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ABSTRACT

This curriculum guide was designed for use in postsecondary instrumentation technology education programs in Georgia. Its purpose is to provide for development of entry level skills in instrumentation technology in the areas of knowledge, theoretical structure, tool usage, diagnostic ability, related supportive skills, and occupational survival skills. The first section explains the philosophies, purposes, and goals of vocational education in Georgia. Section 2 presents employability skills related to the occupational area of instrumentation technology, specific occupational titles, student exit points, and tasks cross referenced to the Dictionary of Occupational Titles. Section 3, the largest part of the guide, provides unit guides for each task. (For each task, a task description, student performance objective, suggested instructional activities, instructional materials, evaluation section, and suggested instruction hours are included.) Section 4 contains the curriculum structure and course outline, while student record forms and competency certificates make up section 5. The last unit contains facility guidelines, with drawings, for group instruction and individualized instruction facilities. Appendixes to the guide contain references and resources, information on teaching special needs students, and definitions of terms. (KC)

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INSTRUMENTATION TECHNOLOGY

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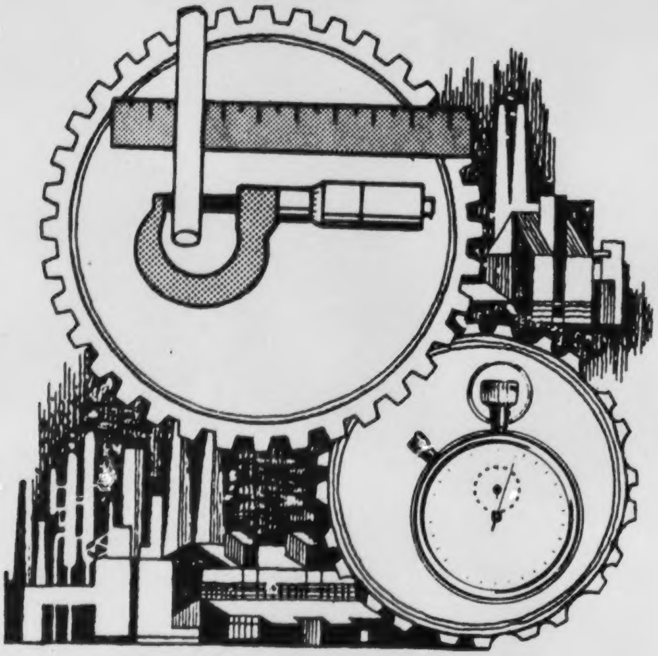

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VOLUME I

CURRICULUM GUIDE

Georgia Department of Education

INSTRUMENTATION TECHNOLOGY

Developed Under Contractual Agreement with

Division of Program Development
Office of Vocational Education
Georgia Department of Education
Atlanta, Georgia 30334
Charles McDaniel, State Superintendent of Schools
1981

INSTRUMENTATION TECHNOLOGY

VOLUME I

Developed By
The University of Georgia

Under the Direction of
Dr. Paul Scott
Vocational Education Materials Center
Division of Vocational Education
College of Education

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POLICIES AND PROCEDURES FOR THE CENTER

PURPOSE OF THE CENTER

The Vocational Education Materials Center functions within the division of Vocational Education, University of Georgia. This Center operates under grants from the U.S. Office of Education, and the Georgia State Department of Education with the support of the College of Education. The Center is comprehensive in its commitment and approach to the development and dissemination of materials in the broad field of Vocational Education.

The purpose of the Center is to increase the capability of Georgia's delivery system for Vocational Education. Specifically, the Center is committed to:

1. Develop materials to assist in the implementation of proposed curricula and to enhance the teaching Vocational Education.
2. Conduct and report curriculum research related to Vocational Education.
3. Provide a production and dissemination center to Vocational Education materials.
4. Provide direct experiences in curriculum development and diffusion for advanced graduate stduents.
5. Enable faculty members to participate in the development and implementation of a variety of curriculum materials.

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INSTRUMENTATION TECHNOLOGY - VOLUME I

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PURPOSE AND UTILIZATION OF THE CURRICULUM GUIDES

The purpose of this curriculum guide is to provide a suggested model for organizing vocational instructional content. In many cases, more material is available than may be needed, there fore, an instructor will need to adapt the content to meet his/her program needs.

While the guide is primarily oriented towards the classroom, whether as a primary resource or as a supplement to other teaching materials; it may also assist administrators, counselors and lay people involved in local school systems. The following outline provides an overview of the various ways these groups may utilize the curriculum guides.

a) Vocational teachers.

1. Provide a guide for organizing their program of instruction,
2. Assist in establishing program objectives,
3. Serve as a curriculum materials resource guide,
4. Improve communications with employers and advisory committees
5. Facilitate competency based instruction,
6. Facilitate either group or self-paced instruction,
7. Include content by quarter and semester,
8. Cross-reference with existing state developed instructional materials (PLACE packages and post secondary I.I.).

b) Vocational supervisors and administrators.

1. Assist in defining the scope and content of their programs,
2. Provide a means to improve curriculum management functions,
3. Serve as a guide for admissions and job placement functions,
4. Improve communications with employers and advisory committees.

c) Counseling and guidance staff.

1. Provide a data base for counseling and guidance personnel,
2. Identify student exit points (Career Options),
3. Serve as guide for admissions and job placement,

4. Correlate with new State Board of Education graduation requirements,
5. Provide specific content sequencing by quarter and semester for student scheduling,
6. Provide (a) curriculum options for the disadvantaged handicapped student, (b) curriculum modifications for SPECIAL NEEDS students, (c) typical admission requirements for regular and SPECIAL NEEDS students.

(d) Local Curriculum Coordination Committees.

1. Serve as a guide in working out articulation arrangements,
2. Improve definitions of the relationship between secondary clusters and post secondary specialized programs.

Vocational teachers, supervisors and administrators, counseling and guidance staff and local curriculum coordination committees will be primary users of this guide, however, the use of the guide is not limited to these groups, but by any and all groups directly related in designing a vocational curriculum.

-Foreword-

It has been the privilege of the Division of Vocational Education, University of Georgia, to participate in the development of 48 curriculum guides for Georgia vocational education programs. This work was sponsored by the Division of Program Development, Office of Vocational Education, State Department of Education. The completion of these guides meets a long standing need to provide a comprehensive curriculum overview of the vocational education programs available in Georgia schools. This developmental activity involved one of the largest professional staffs ever assembled for such work. Numerous teachers, teacher educators and state staff members have either written parts of the guides or served on the field review teams. These professionals were supported by a myriad of technical people and a host of typists who literally worked from dawn to dusk to ensure that the guides were produced in a timely fashion.

Be assured that this guide is not intended to be your curriculum or the curriculum of any school. The purpose of this project staff, and I am sure of the state OVE staff, is to offer a guide with supporting resources and teaching ideas from which the vocational instructor can extract a curriculum that meets local needs. The guide, however, does simplify curriculum decisions concerning sequencing and the selection of resources and media support.

The Task Linkage Project and appropriate V'TECS catalogs were used as the beginning point for this guide and all of the others. To assure that these task listings were directly related to Georgia vocational education programs and industry, they were subjected to additional study and review by appropriate teachers.

At some point in the future, this guide will need to be revised. To ensure that such a revision truly reflects the needs of Georgia's vocational education programs, the developers need your reactions, comments and ideas. We will also be interested in how you use this guide. Let us hear from you.

Paul Scott
Curriculum Guide Projects I & II

SECTION I

PHILOSOPHY, PURPOSE & OBJECTIVES

SECTION I

Section I Content List

State Philosophy and Goals
Local Philosophy and Goals

Section I provides an overview of the philosophies, purposes and goals for vocational education in the State of Georgia. These are applied to vocational education at the postsecondary level, however, it is recognized that more specific philosophies, purposes and goals will be applicable depending on the character of the local program.

VOCATIONAL EDUCATION IN GEORGIA

A. PHILOSOPHY

The Georgia Board of Education perceives vocational education as a vital component in the education of the young and adult citizens of this State. Appropriate programs of vocational education and ancillary services should be made readily available to individuals in middle schools, vocational divisions of junior colleges, vocational centers, the Quick Start program and other adult programs designed to train or retrain workers for useful and satisfying employment.

Special services and assistance must be provided to those who need it in order to participate or benefit from vocational education. This includes women, minorities, the displaced homemaker and other displaced workers, those with limited English-speaking ability, the disadvantaged and the handicapped.

Since men and women spend the greater part of their lives at some form of work, the State should provide opportunities for all its citizens to develop the knowledge, skills and attitudes necessary for them to secure personally satisfying and socially useful employment.

B. PURPOSE

The purpose of vocational education shall be to improve the economic well-being of Georgia citizens by preparing individuals, through organized learning experiences, to select, obtain and advance in recognized occupations.

POSTSECONDARY VOCATIONAL EDUCATION

A. PURPOSE

The purpose of postsecondary vocational-technical education in Georgia is to improve the economic well-being of adult citizens by providing access to high quality vocational-technical training for skilled and semi-skilled occupations, for improvement of existing skills or for retraining in a new occupation.

B. OBJECTIVES

1. To provide vocational-technical education programs and ancillary services commensurate with the needs and interests of students and available job opportunities.

2. To provide vocational-technical education programs which are current with the state-of-the-art, competency-based, and offer multiple exit points to accommodate the students' occupational objectives.

3. To provide vocational-technical education programs which are articulated with available high school counterparts, to facilitate an easy transition from secondary to post-secondary levels without loss of credit.

4. To provide vocational-technical education programs such that 75% of those individuals who leave or complete a program of occupational preparation will find employment in the field, or a related field, for which trained.

5. To provide those guidance, counseling, financial aid, evaluative, job placement, remedial and other supportive programs and services needed by students to enroll, complete a program and become, or remain, employable in a skilled or semi-skilled occupation.

6. To provide needed assistance to special populations to include women, minorities, limited English-speaking, the displaced homemaker and other displaced workers, the disadvantaged and the handicapped.

7. To provide vocational-technical education programs for full-time and part-time students on campus during the day as well as the evening hours, and to provide appropriate programs for full-time and part-time students off campus in businesses and industries, comprehensive high schools and other locations within the respective schools' service areas.

8. To serve as a center for the delivery of postsecondary and adult vocational-technical education programs and services for the community and assigned service area.

STATEMENT OF LOCAL SYSTEM PHILOSOPHY, PURPOSE AND OBJECTIVES FOR VOCATIONAL EDUCATION

(This page is intentionally left blank so that local systems may insert their copy of philosophy, purpose and goals for vocational education.)

SECTION II

PROGRAM DESCRIPTION & RELATED INFORMATION

SECTION II

Section II Content List

- Employability Skills
- Instrumentation Technology Occupational Description
- Instrumentation Technology Program Objective
- Definition of the D.O.T. Code
- Description of Instrumentation Technology D.O.T.
- Task Listing by D.O.T. Code

The major goal of vocational education in Georgia is to prepare individuals, through organized learning experiences, to select, obtain and advance in recognized occupations. Section II provides an overview of employability skills that are desirable in any occupation and relates their significance to the specific occupational area of Instrumentation Technology.

The Instrumentation Technology Program Objective contains the specific occupational titles. These occupational titles are further explained in the description of the occupational exit points and task listing. The concentration of the program is based on these tasks.

EMPLOYABILITY SKILLS

Employability skills exert a great deal of influence on a person's ability to get and keep a job. Surveys indicate that more people lose their jobs because of poor attitudes toward their job than for lack of job skills. For this reason it is important that information concerning the following employability skills be provided as an ongoing part of the program.

1. Getting a job
    a. Filling out job applications
    b. Developing a resume
    c. Preparing for a job interview

2. Keeping a job
    a. Be on time and regular in attendance
    b. Maintain a fair share of the work-load
    c. Work without supervision
    d. Meet production schedules
    e. Properly care for and use equipment
    f. Dress appropriately for the job
    g. Maintain good personal hygiene
    h. Develop and maintain good communication with supervisors and co-workers

A recent study sponsored by the Illinois Department of Adult, Vocational and Technical Education and conducted by the University of Illinois, "Survival Skills: Mastering the Human Aspects of Work", has identified twelve topics that might be developed into instructional modules for teaching occupational survival skills. The author, Robert E. Nelson, outlines these topics listed below and on the next page, each followed by a general objective which indicates the relationship between the topic and the survival skills required to maintain a job.

*"1. Working in an Organization: To familiarize students with the reasons for the formation of organizations and the common characteristics of organizations.

2. Understanding Self and Others: To have students develop insights into causes of human behavior and learn to interpret their own behavior and the behavior of other.

3. Motivation for Work: To have students develop and understanding of motivations into the work they perform.
4. Interpersonal Relations: To have students develop concepts and skills in interpersonal relations and apply them to work situations.
5. On-the-Job Communication: To have students understand the importance of effective communication and learn ways of communicating effectively on the job.
6. Using Creativity on the Job: To make students aware of their creative potential and to practice using their creative ability in hypothetical on-the-job situations.
7. Authority and Responsibility: To have students develop an understanding of the concepts of authority, power, influence, and responsibility as they apply to work situations.
8. Problem Solving: To have students develop skill in applying problem solving to their work.
9. Coping with Organizational Change: To make students aware of the process of organizational change and the techniques for coping with organizational change.
10. Coping with Organizational Conflict: To make students aware of the sources and types of conflicts encountered on the job and recognize ways of coping with conflicts in an organization.
11. Leadership: To have students recognize the need for leadership in work groups and increase their understanding of the leadership role in work situations.
12. Adapting and Planning for the Future: To have students develop perspectives of work in the future and the ability to plan for anticipated changes in their work roles."

*Abstracted from the article, "Survival Skills: Mastering the Human Aspects of Work," by Robert E. Nelson, American Vocational Journal, November 1977.

DESCRIPTION OF OCCUPATION*

Nature of the Work

Automated manufacturing and industrial processes, oceanographic and space exploration, weather forecasting, satellite communication systems, environmental protection, and medical research have helped to make instrumentation technology a fast-growing field. Technicians help develop and design complex measuring and control devices such as those in a spacecraft that sense and measure changes in heat or pressure, automatically record data, and make necessary adjustments. These technicians have extensive knowledge of physical sciences as well as electrical-electronic and mechanical engineering.

Working Conditions

Technicians work under a wide variety of conditions. Most work regular hours in laboratories and industrial plants. Others work part or all of their time outdoors. Some occasionally are exposed to safety or health hazards from equipment or materials.

Training, Other Qualifications, and Advancement

Although persons can qualify for technician jobs through many combinations of work experience and education, most employers prefer applicants who have had some specialized technical training. Specialized training is available at technical institutes, junior and community colleges, area vocational-technical schools, extension divisions of colleges and universities, and vocational-technical high schools.

Persons also can qualify for technician jobs by less formal methods. Workers may learn through on-the-job training, apprenticeship programs, or correspondence schools. However, postsecondary training is becoming increasingly necessary for advancement to more responsible jobs.

Those interested in a career as a technician should have an aptitude for mathematics and science and enjoy technical work. An ability to do detailed work with a high degree of accuracy is necessary; for design work, creative talent also is desirable. Technicians are part of a scientific team, and often work closely with engineers and scientists as well as other technicians and skilled workers. Some technicians, such as repair and maintenance technicians, should be able to work independently and to deal effectively with customers.

Instrumentation technicians usually begin work as trainees in routine positions under the direct supervision of an experienced technician, scientist, or engineer. As they gain experience, they receive more responsibility and carry out a particular assignment under only general supervision. Instrumentation technicians may eventually move into supervisory positions. Those who have the ability and obtain additional education occasionally may be promoted to positions as scientists or engineers.

Employment Outlook

Employment opportunities for instrumentation technicians are expected to be favorable through the 1980's. Opportunities will be best for graduates of postsecondary school technician training programs. Besides openings resulting from the slightly faster than average growth expected in this field, additional technicians will be needed to replace those who die, retire, or leave the occupation. Industrial expansion and the increasing comlexity of modern technology underlie the anticipated increase in demand for technicians. Many will be needed to work with the growing number of engineers and scientists in developing, producing, and distributing new and technically advanced products. Automation of industrial processes and continued growth of new areas of work such as environmental protection and energy development will add to the demand for technical personnel.

The anticipated growth of research and development expenditures in industry and government also should increase requirements for technicians.

Sources of Additional information

For information on careers in instrumentation technology contact:

Engineers Council for Professional Development, 345 East 47th St., New York, NY 10017.

Information on schools offering technician programs is available from:

National Association of Trade and Technical Schools, 2021 K. St., NW, Washington, DC 20006.

State departments of education also have information about approved technical institutes, junior colleges, and other educational institutions within the State offering post-high school training for specific technical occupations. Other sources include:

American Association of Community and Junior Colleges, One Dupont Circle, Suite 410, Washington, DC 20036.

National Home Study Council, 1601 18th St. NY., Washington, DC 20009.

*_Occupational Outlook Handbook_, 1980-81 ed.

INSTRUMENTATION TECHNOLOGY PROGRAM OBJECTIVE

Given appropriate instruction, as suggested by this guide, a student completing the program should demonstrate entry level skills of Instrumentation Technology in the areas of knowledge, theoretical structure, tool usage, diagnostic ability, related supportive skills and occupational survival skills.

As the student progresses through the program, sufficient competencies will be acquired to enable the student to enter the occupational field at the following D.O.T. Codes.*

Instrumentation Technician	(D.O.T. Code 003.261-010)
Test Technician	(D.O.T. Code 019.161-014)
Calibration Laboratory Technician	(D.O.T. Code 019.281-010)
Instrument Mechanic	(D.O.T. Code 710.281-026)
Instrument Technician	(D.O.T. Code 710.281-030)
Inspector	(D.O.T. Code 710.381-034)
Inspector, Mechanical and Electrical	(D.O.T. Code 710.381-038)
Instrument Mechanic	(D.O.T. Code 710.381-042)
Tester, Electronic Scale	(D.O.T. Code 710.381-046)
Inspector	(D.O.T. Code 710.384-014)
Assembler	(D.O.T. Code 710.681-010)
Calibrator	(D.O.T. Code 710.681-014)
Instrument-Technician Helper	(D.O.T. Code 710.684-030)
Instrument Checker	(D.O.T. Code 710.687-026)
Electrical-Instrument Repairer	(D.O.T. Code 729.281-026)
Electrical-Equipment Tester	(D.O.T. Code 729.381-010)

*Dictionary of Occupational Titles, 1977 ed.

DEFINITION OF D.O.T. CODE*

As a result of technological, economic and sociological influences, nearly every job in the economy is performed slightly differently from any other job. Every job is also similar to a number of other jobs. In order to look at the millions of jobs in an organized way, job titles are designated a 9-digit occupational code. Each set of three digits in the D.O.T. Code has a specific purpose or meaning that differentiates it from all other codes.

The first three digits of the D.O.T. Code identify a particular occupational group. In the code 652.382-010, the first digit indicates an occupational category. The second digit refers to a division within the occupational category. The third digit defines a specific occupational group within a division.

The middle three digits of the D.O.T. Code 652.382-010 are the worker function rating of the tasks performed in the occupation. Every job requires a worker to function, to some degree, in relation to data, people and things. A separate digit expresses the worker's relationship to each of these three groups. Worker functions involving more complex responsibility and judgment are assigned lower numbers while functions which are less complicated have high numbers.

The last three digits of the D.O.T. Code 652.382-010 indicate the alphabetical order of titles within 6-digit code groups. They serve to differentiate a particular occupation from all others. A number of occupations may have the same first six digits, but no two D.O.T. Code can have the same nine digits.

*Dictionary of Occupational Titles, 1977 ed.

DESCRIPTION OF OCCUPATIONAL EXIT POINTS*

003.261-010 INSTRUMENTATION TECHNICIAN (profess. & kin.)

Devises, sets up, and operates electronic instrumentation and related electromechanical or electrohydraulic apparatus involved in operational and environmental testing of mechanical, structural, or electrical equipment, and translates test data for subsequent use by engineering personnel in making engineering design and evaluation decisions: Selects, installs, calibrates, and checks out sensing, telemetering, and recording instrumentation and circuitry, and develops specifications for nonstandard apparatus according to engineering data, characteristics of equipment under test, and capabilities of procurable test apparatus. Sketches and builds or modifies jigs, fixtures, instruments, and related apparatus, and verifies dimensional and functional acceptability of devices fabricated by craft or technical personnel. Performs preventative and corrective maintenance of test apparatus and peripheral equipment. Directs technical personnel in installation of object in test chamber or other test facility. Operates test apparatus during test cycle to produce, regulate, and record effects of actual or simulated conditions, such as vibration, stress, temperature, humidity, pressure, altitude, and acceleration. Mathematically reduces test data to usable form, and prepares graphs and written reports to translate test results into meaningful terms, such as speed-temperature-horsepower ratios. May be designated according to equipment tested as ROCKET-CONTROL TECHNICIAN (profess. & kin.), or according to nature of test as ENVIRONMENTAL-RESEARCH-TEST TECHNICIAN (profess. & kin.).

019.161-014 TEST TECHNICIAN (profess. & kin.)

Prepares specifications for fabrication, assembly, and installation of apparatus and control instrumentation used to test experimental or prototype mechanical, electrical, electromechanical, hydromechanical, or structural products, and conducts tests and records results, utilizing engineering principles and test technology: Confers with engineering personnel to resolve fabrication problems relating to specifications, and to review test plans, such as types and cycles of tests, conditions under which tests are to be conducted, and duration of tests. Fabricates precision parts for test apparatus, using metal working machines, such as lathes, milling machines, and welding equipment, or interprets specifications for workers fabricating parts. Examines parts for conformance with dimensional specifications, using precision measuring instruments. Coordinates and participates in installing unit or system to be tested in test fixtures, connecting valves, pumps, hydraulic, mechanical or electrical controls, cabling, tubing, power source, and indicating instruments. Activates controls to apply electrical, hydraulic, pneumatic, or mechanical power and subject test item to successive steps in test cycle. Monitors controls and instruments and records test data for engineer's use. May recommend changes in test methods or equipment for engineering review. Workers are classified according to engineering specialty or type of product tested.

019.281-010 CALIBRATION LABORATORY TECHNICIAN (aircraft-aerospace mfg.; electronics) standards laboratory technician.

Tests, calibrates, and repairs electrical, mechanical, and electronic measuring and indicating instruments for conformance to established standards, and assists engineering personnel in development of calibration standards: Plans sequence of testing and calibration procedures for instruments, using blueprints, schematic drawings, and other data. Sets up standardized laboratory equipment to test and measure accuracy of other instruments which are used to record voltage, heat, magnetic resistance, and other factors. Disassembles recording systems and instrumentation, using handtools, and inspects parts for defects. Measures parts for conformity with specifications, using micrometers, capipers, and other precision instruments. Repairs or replaces parts, such as jewels, and electronic units, using jeweler's lathe, files, soldering iron, and other tools. Reassembles and adjusts instrument to calibration standard. Devises formulas to solve problems in measurements and calibrations. Writes procedures and practical guides under direction of engineers to minimize calibration time and maintain precision accuracy of instruments, measuring devices, and recording equipment.

710.281-026 INSTRUMENT MECHANIC (any ind.) Instrument-maintenance mechanic.

Installs, repairs, maintains, and adjusts indicating, recording, telemetering, and controlling instruments used to measure and control variables, such as pressure, flow, temperature, motion, force, and chemical composition, using handtools and precision instruments: Disassembles malfunctioning instruments, and examines and tests mechanism and circuitry for defects. Troubleshoots equipment in or out of control system and replaces or repairs defective parts. Reassembles instrument and tests assembly for conformance with specifications, using instruments, such as potentiometer, resistance bridge, manometer, and pressure gage. Inspects instruments periodically and makes minor calibration adjustments to insure functioning within specified standards. May adjust and repair final control mechanisms, such as automatically controlled valves or positioners. May calibrate instruments according to established standards. May be designated according to type of instrument repaired as AIRCRAFT INSTRUMENT REPAIRER (air trans.); METER SERVICER (any ind.); PANEL-INSTRUMENT REPAIRER (any ind.); RADIOLOGICAL INSTRUMENT TECHNICIAN (gov. ser.); X-RAY-CONTROL-EQUIPMENT REPAIRER (any ind.). May perform duties as described under GROUP LEADER (any ind.).

710.281-030 INSTRUMENT TECHNICIAN (light, heat, & power)
oscillograph technician.

Inspects, tests, adjusts, and repairs electric, electronic, mechanical, and pneumatic instruments and systems used to indicate, record, and control generating operations in conventional or nuclear power electric generating plant: Inspects meters, indicators, and gages, to detect abnormal fluctuations. Tests accuracy of flowmeters, pressure gages, temperature indicators, controllers, radiation counters or detectors, and other recording, indicating or controlling instruments to locate defective components in system, using test equipment, such as pressure gages, mercury manometers, poteniometers, pulse and signal generators, oscilloscopes, transistor curve tracers, and ammeters, voltmeters, and wattmeters. Traces out and tests electronic solid state and vacuum tube circuitry and components to locate defective parts in analog and digital, protection, or radiation monitoring systems, using test equipment, schematics, and maintenance manuals. Removes defective instruments from system, decontaminates, disassembles, and cleans instruments, and replaces defective parts, using handtools. Reassembles instruments and replaces instruments in system, using handtools. Lubricates instruments and replaces defective wiring and tubing. Calibrates readings on instruments according to standards and adjusts phasing and alines stages to insure accuracy of recording and indicating function. Records calibrations made, parts and components used, and inventory of parts on hand. Prepares schematic drawings, sketches, and reports to reflect changes or alterations made in instruments, circuits, and systems. May be designated according to type power plant as NUCLEAR-PLANT-INSTRUMENT TECHNICIAN (light, heat, & power); INSTRUMENT REPAIRER, STEAM PLANT (light, heat, & power).

710.381-034 INSPECTOR (inst. & app.)

Inspects, tests, and calibrates control instruments and devices, such as thermostats, pressure regulators, temperature controls, and furnace, burner, and water controls to insure specified operating performance, using handtools and test equipment: Reads quality control manual specifications and test manuals to obtain data for performing testing and calibrating activities on specific device. Selects and installs adaptors, gages, or holding devices on test fixture, using handtools. Connects instrument or device to be tested to test fixture or equipment to prepare for testing or calibrating activities. Sets controls to measure pressure, temperature, vacuum, or current flow according to specifications, and activates test equipment. Observes readings on meters and gages and action of device to ascertain functional defects or calibration requirements. Turns adjustment screws or bends contact points to obtain specified operational performance of device or control being tested or calibrated, using screwdrivers, pliers, and feeler gages. Rejects malfunctioning devices and routes devices to specified department for rework or salvaging of parts. May disassemble devices to determine cause of defective operation and notify supervisory personnel of findings. May seal adjustment screws with compound to prevent readjustment of settings and loss of calibration. May be designated according to activity performed as ASSEMBLY TESTER (inst. & app.); CALIBRATION CHECKER (inst. & app.) 1; CALIBRATOR (inst. & app.); THERMOSTAT CALIBRATOR (inst. & app.); THERMOSTAT TESTER (inst. & app.).

710.381-038 INSPECTOR, MECHANICAL AND ELECTRICAL (inst. & app.)

Inspects and tests completed instruments, such as master and gyro indicators, and their subassemblies, performing any combination of following duties: Examines metal and glass parts for surface scratches and nicks, internal threads, position of assembled parts, presence of bonding adhesive at designated points, and adequacy of soldering. Verifies dimensions of parts and location of holes, grooves, and other points according to blueprints, using measuring devices, such as calipers, micrometers, dial indicators, and height and depth gages. Turns parts, such as gears and verniers, to test freedom of movement. Connects assembly to testing devices, observes dials, and compares readings against standards to determine electrical characteristics. Connects assembly to outlet and counts revolution of disk attached to generator during timed interval to ascertain rate of generator speed. Moves gears to turn dial at desired point and tightens or loosens control nuts on vernier to synchronize movement of both units. May inspect and test purchased parts and subassemblies and be designated RECEIVING INSPECTOR (inst. & app.).

710.381-042 INSTRUMENT MECHANIC (inst. & app.)

Tests, calibrates, and repairs aneroid barometers to obtain specified operational performance, using handtools and test equipment: Places aneroid barometer in vacuum chamber and connects barometer to master barometer (mercurial barometer). Starts vacuum pump to decrease atmospheric pressure in vacuum chamber and records variances of readings between aneroid and master barometer at different atmospheric pressures. Calculates adjustments required to calibrate aneroid barometer and calibrates barometer, using handtools. Retests calibrated barometer to insure calibration agrees with master. Disassembles, inspects, and replaces defective parts in barometers. May test calibration of aneroid barometers, using vacuum chamber and radio frequency signals recorded on tape and be known as CALIBRATOR (inst. & app.) 11.

710.381-046 TESTER, ELECTRONIC SCALE (bal. & scales)

Tests assembled electronic scale components to detect missing parts, loose wires, and defective solder joints, using oscilloscope and voltmeter. Disassembles and repairs or replaces parts.

710.384-014 INSPECTOR (bal. & scales)

Inspects and tests parts, subassemblies, and finished scales and balances for conformance to quality standards, using written specifications, precision measuring instruments, and handtools: Inspects purchased or in-plant-fabricated parts for observable defects and tests specific components for hardness, dimensions and tolerance, using blueprints, hardness testing machine, and precision measuring instruments, such as micrometers, calipers, and thread gages. Inspects and tests assembled scales and balances for appearance, allowable tolerances, reliability (repeated use), and accuracy (calibration), using master weights. Rejects unacceptable parts, subassemblies, and completed scales and prepares reports indicating defects and suspected cause.

710.681-010 ASSEMBLER (inst. & app.)

Assembles instruments and devices, such as control valves, electric motors, relays, thermostats, barometers, compasses, tachometers, oil pressure and water temperature gages, hygrometers, thermometers, rheostats, and gyroscopes, using soldering iron, jewelers handtools, tweezers, alinement mirrors, binocular microscope, eye loupe, and other handtools and work aids: Inspects component parts to insure quality of materials, using binocular microscope and eye loupe. Assembles component parts of instrument or device according to diagrams or written and oral instructions, using soldering iron, handtools, and hydraulic press. Inspects and tests assembled article for assembly defects, using gages, and test instruments, such as ohmmeters and voltmeters. May be designated according to product assembled as COUNTER ASSEMBLER (inst. & app.); ODOMETER ASSEMBLER (inst. & app.); PEDOMETER ASSEMBLER (inst. & app.); SPEEDOMETER ASSEMBLER (inst. & app.); TACHOMETER ASSEMBLER (inst. & app.); THERMOSTAT ASSEMBLER (inst. & app.); VALVE ASSEMBLER (inst. & app.).

710.681-014 CALIBRATOR (inst. & app.) 1

Performs any combination of tasks involved in calibrating instruments, such as radiation detection and measuring devices, tachometers, gyroscopes, thermostats, timing, and pressure-regulating devices: Selects and installs adapter and indicating gages on test fixture according to written specifications. Sets controls to regulate current flow, timing cycle, pressure, or temperature, to specifications for device being tested. Positions dial plate of controls at reference point and adjusts calibration screw, bearing, or calibrating arm so that contact points open and close at specified temperature or pressure. Bends contact blades of device to adjust blades for length of travel time, using feeler gages and handtools. Positions potentiometer blades to obtain specified galvanometer reading, using scrwedriver and feeler gage. Places sealing compound on adjustment screws to prevent readjustment of breaker points or solders wire of calibrating arm to adjusting bearing to make tension permanent. May be designated according to instrument calibrated as FLOAT-TANK CALIBRATOR (inst. & app.); GAGE CALIBRATOR (inst. & app.); SPEEDOMETER CALIBRATOR (inst. & app.); THERMOSTAT SETTER (inst. & app.).

710.684-030 INSTRUMENT-TECHNICIAN HELPER (light, heat, & power)

Assists INSTRUMENT TECHNICIAN (light, heat, & power) in repair and maintenance of metering instruments for electric-power generating equipment, such as boilers and turbines: Removes, dismantles and assembles instruments, using mechanic's and electrician's handtools. Performs other duties as described under HELPER (any ind.).

710.687-026 INSTRUMENT CHECKER (inst. & app.) time checker.

Inspects instruments, such as thermostats and sequence controls used on refrigerators, clothes dryers, and air conditioners for conformance to specifications: Examines instrument for such defects as dents, scratches, loose solder joints, and loose terminals. Attaches instrument to electronic test equipment and observes signal light to detect defective operation. Stamps acceptable instruments and places them in boxes. May be designated according to instrument inspected as SEQUENCE-CONTROL CHECKER (inst. & app.); THERMOSTAT CHECKER (inst. & app.).

729.281-026 ELECTRICAL-INSTRUMENT REPAIRER (any ind.) instrument maker; instrument repairer.

Repairs, calibrates, and tests instruments, such as voltmeters, ammeters, resistance bridges, galvanometers, temperature brides, and temperature controlling recording gages and instruments, using jewelers' tools, electricians' tools, handtools, and measuring instruments: Tests instruments for resistance, voltage, and other characteristics, using potentiometer, voltage divider, and other testing devices. Disassembles instruments, using handtools, and examines parts defects. Measures, cuts, and fits glass for meters and instruments, using glass cutter. Repairs or replaces defective parts of instruments, using handtools, soldering equipment, grinders, calipers, micrometers, and dividers. Reassembles instruments, following circuit diagrams and using jewelers' tools. Tests new and repaired instruments, using test board. May operate lathe and drill press to make replacement parts. May plan, construct, and assemble test panels for experimental and production testing. May keep records on repair and calibration of instruments. May rebuild induction cores for electric furnaces. May install, repair, and adjust electronically controlled dynamometers and be known as DYNAMOMETER REPAIRER (elec. equip.).

729.381-010 ELECTRICAL-EQUIPMENT TESTER (aircraft-aerospace mfg.) inspector, precision and electrical assemblies; tester, electrical accessories.

Tests and adjusts electrical equipment and accessories to in insure conformance to specifications preparatory to installation in aircraft: Examines accessories and equipment, such as alternators, batteries, belts, bomb releases, booster coils, circuit breakers, condensors, electric actuators, limit switches, solenoids, and starter control valves, for surface defects, such as rust, grease, and dirt. Connects accessories and equipment to instruments, such as voltmeter, ammeter, oscilloscope, and torque indicator, and tests for voltages under loads, output and input of power at various operating temperatures, amount of current used at different voltages, electrical leakages, short circuits and open circuits, and electric motor torques. Adjusts moving parts as indicated by tests, using handtools. Stamps or attaches tags to approved equipment. Records results of tests. May test effects of vibration on equipment and accessories, using vibration testing equipment. May design, lay out, and construct special testing jigs. May measure parts of electro-mechanical assemblies for conformance to specifications, using micrometers, calipers, and gages. May test and adjust electronic equipment.

*Dictionary of Occupational Titles, 1977 ed.

TASK LISTING BY D.O.T. CODE

In this section the occupational exit points from the curriculum are cross referenced with the tasks which are required for employment in each job title. On the line following each task an x appears in the column of each job title to which to task applies. All the tasks listed in this matrix are taught in the curriculum presented in this guide. A detailed treatment of each task appears in the Unit Guides section of this curriculum guide.

TASK LISTING BY DOT CODE

INSTRUMENTATION TECHNOLOGY

POSSIBLE EXIT POINTS

TASK NO.	TASK NAME	Instrumentation Technician	Test Technician	Calibration Laboratory Technician	Instrument Mechanic	Instrument Technician	Inspector	Inspector, Mechanical and Electrical	Instrument Mechanic	Tester, Electronic Scale	Inspector	Assembler	Calibrator	Instrument Technician Helper	Instrument Checker	Electrical - Instrument Repairer	Electrical - Equipment Tester
	DOT NO.	003.261-010	019.161-014	019.281-010	710.281-026	710.281-030	710.381-034	710.381-038	710.381-042	710.381-046	710.384-014	710.681-010	710.681-014	710.684-030	710.687-026	729.281-026	729.381-010
	SAFETY, PROCEDURES AND TOOLS																
SPT-01	Identifying plant safety procedures	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPT-02	Observing safety precautions for tools and equipment	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPT-03	Identifying machinery safeguards	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPT-04	Observing safety in handling materials	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPT-05	Identifying work area safety precautions	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPT-06	Identifying fire prevention procedures	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPT-07	Handling hazardous materials	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

TASK LISTING BY DOT CODE

INSTRUMENTATION TECHNOLOGY

POSSIBLE EXIT POINTS

TASK NO.	TASK NAME	Instrumentation Technician	Test Technician	Calibration Laboratory Technician	Instrument Mechanic	Instrument Technician	Inspector	Inspector, Mechanical and Electrical	Instrument Mechanic	Tester, Electronic Scale	Inspector	Assembler	Calibrator	Instrument Technician Helper	Instrument Checker	Electrical - Instrument Repairer	Electrical - Equipment Tester
	DOT NO.	003.261-010	019.161-014	019.281-010	710.281-026	710.281-030	710.381-034	710.381-038	710.381-042	710.381-046	710.384-014	710.681-010	710.681-014	710.684-030	710.687-026	729.281-026	729.381-010
SPT-08	Observing electrical safety precautions	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPT-09	Identify personal protection gear	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPT-10	Identifying and using hand tools	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPT-11	Identifying and using power tools	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPT-12	Identifying types of fasteners	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPT-13	Identifying and using wrenches and screwdrivers	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPT-14	Identifying and using pipefitting tools	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPT-15	Identifying and using plumbing tools	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPT-16	Identifying and using electrical tools	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

TASK LISTING BY DOT CODE

INSTRUMENTATION TECHNOLOGY

POSSIBLE EXIT POINTS

TASK NO.	TASK NAME	Instrumentation Technician 003.261-010	Test Technician 019.161-014	Calibration Laboratory Technician 019.281-010	Instrument Mechanic 710.281-026	Instrument Technician 710.281-030	Inspector 710.381-034	Inspector, Mechanical and Electrical 710.381-038	Instrument Mechanic 710.381-042	Tester, Electronic Scale 710.381-046	Inspector 710.384-014	Assembler 710.681-010	Calibrator 710.681-014	Instrument Technician Helper 710.684-030	Instrument Checker 710.687-026	Electrical - Instrument Repairer 729.281-026	Electrical - Equipment Tester 729.381-010
SPT-17	Identifying and using sheet metal tools	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPT-18	Identifying and using metalworking tools	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPT-19	Identifying and using hoisting and pulling tools	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	BLUEPRINTS, SCHEMATICS AND DIAGRAMS																
BSD-01	Identifying basic principles of blueprint reading	X	X	X	X	X	X	X		X	X	X	X		X	X	X
BSD-02	Identifying elements of machine drawing	X	X	X	X	X	X	X			X	X	X		X	X	X

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TASK LISTING BY DOT CODE

INSTRUMENTATION TECHNOLOGY

POSSIBLE EXIT POINTS

TASK NO.	TASK NAME	Instrumentation Technician	Test Technician	Calibration Laboratory Technician	Instrument Mechanic	Instrument Technician	Inspector	Inspector, Mechanical and Electrical	Instrument Mechanic	Tester, Electronic Scale	Inspector	Assembler	Calibrator	Instrument Technician Helper	Instrument Checker	Electrical - Instrument Repairer	Electrical - Equipment Tester
	DOT NO.	003.261-010	019.161-014	019.281-010	710.281-026	710.281-030	710.381-034	710.381-038	710.381-042	710.381-046	710.384-014	710.681-010	710.681-014	710.684-030	710.687-026	729.281-026	729.381-010
BSD-03	Identifying hydraulic and pneumatic drawings	X						X									
BSD-04	Reading building drawings	X						X									
BSD-05	Reading electrical drawings	X						X				X	X		X	X	X
BSD-06	Reading pipe system drawings	X						X									
BSD-07	Reading sheet metal drawings	X						X									
BSD-08	Using shop math to interpret blueprints	X						X		X	X	X	X		X	X	X
BSD-09	Sketching schematic diagrams	X						X									
BSD-10	Identifying types of schematics used in plant engineering	X						X			X		X		X	X	X
BSD-11	Identifying the symbols on electrical																

TASK LISTING BY DOT CODE

INSTRUMENTATION TECHNOLOGY

POSSIBLE EXIT POINTS

TASK NO.	TASK NAME	003.261-010 Instrumentation Technician	019.161-014 Test Technician	019.281-010 Calibration Laboratory Technician	710.281-026 Instrument Mechanic	710.281-030 Instrument Technician	710.381-034 Inspector	710.381-038 Inspector, Mechanical and Electrical	710.381-042 Instrument Mechanic	710.381-046 Tester, Electronic Scale	710.384-014 Inspector	710.681-010 Assembler	710.681-014 Calibrator	710.684-030 Instrument Technician Helper	710.687-026 Instrument Checker	729.281-026 Electrical - Instrument Repairer	729.381-010 Electrical - Equipment Tester
	piping and fluid power diagrams	X	X	X	X	X	X	X									
BSD-12	Identifying guidelines for reading schematics	X	X	X	X	X	X	X		X	X	X	X		X	X	X
BSD-13	Identifying electrical symbols	X	X	X	X	X	X	X									
BSD-14	Reading electrical diagrams	X	X	X	X	X	X	X				X	X		X	X	X
BSD-15	Identifying piping symbols	X	X	X	X	X	X	X									
BSD-16	Reading piping schematics	X	X	X	X	X	X	X									
BSD-17	Identifying fluid power symbols	X	X	X	X	X	X	X									
BSD-18	Reading fluid power schematics	X	X	X	X	X	X	X									
BSD-19	Identifying welding symbols	X	X	X	X	X	X	X									
BSD-20	Drawing electrical one-line diagrams from engineering sketches	X	X	X	X	X	X	X								X	

TASK LISTING BY DOT CODE

INSTRUMENTATION TECHNOLOGY

	POSSIBLE EXIT POINTS DOT DESCRIPTION	Instrumentation Technician	Test Technician	Calibration Laboratory Technician	Instrument Mechanic	Instrument Technician	Inspector	Inspector, Mechanical and Electrical	Instrument Mechanic	Tester, Electronic Scale	Inspector	Assembler	Calibrator	Instrument Technician Helper	Instrument Checker	Electrical - Instrument Repairer	Electrical - Equipment Tester
	DOT NO.	003.261-010	019.161-014	019.281-010	710.281-026	710.281-030	710.381-034	710.381-038	710.381-042	710.381-046	710.384-014	710.681-010	710.681-014	710.684-030	710.687-026	729.281-026	729.381-010
TASK NO.	TASK NAME																
BSD-21	Drawing electrical elementary diagrams from engineering sketches	X	X	X	X	X	X	X								X	
BSD-22	Drawing electronic schematic diagrams from engineering sketches	X	X	X	X	X	X	X									
BSD-23	Preparing preliminary sketches	X	X	X	X	X	X	X									
BSD-24	Drawing logic symbols	X	X	X	X	X	X	X									
	PROPERTIES OF MATERIALS																
POM-01	Identifying the physical structure of metals	X	X	X	X	X	X	X			X	X	X		X	X	X
POM-02	Identifying properties of metals	X	X	X	X	X	X	X			X	X	X		X	X	X

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TASK LISTING BY DOT CODE

INSTRUMENTATION TECHNOLOGY

POSSIBLE EXIT POINTS

TASK NO.	TASK NAME	DOT NO. 003.261-010 DOT DESCRIPTION Instrumentation Technician	019.161-014 Test Technician	019.281-010 Calibration Laboratory Technician	710.281-026 Instrument Mechanic	710.281-030 Instrument Technician	710.381-034 Inspector	710.381-038 Inspector, Mechanical and Electrical	710.381-042 Instrument Mechanic	710.381-046 Tester, Electronic Scale	710.384-014 Inspector	710.681-010 Assembler	710.681-014 Calibrator	710.684-030 Instrument Technician Helper	710.687-026 Instrument Checker	729.281-026 Electrical - Instrument Repairer	729.381-010 Electrical - Equipment Tester
POM-03	Identifying non-metal materials	X	X	X	X	X	X	X			X	X	X		X	X	X
POM-04	Identifying properties and applications of carbon	X	X	X	X	X	X	X			X	X	X		X	X	X
POM-05	Identifying properties of rubber	X	X	X	X	X	X	X			X	X	X		X	X	X
POM-06	Identifying properties of industrial chemicals	X	X	X	X	X	X	X			X	X	X		X	X	X
POM-07	Identifying the properties of paints, coatings and their applications	X	X	X	X	X	X	X			X	X	X		X	X	X
POM-08	Identifying the properties of insulating materials and their applications	X	X	X	X	X	X	X			X	X	X		X	X	X
POM-09	Identifying properties and applications of construction materials	X	X	X	X	X	X	X			X	X	X		X	X	X

TASK LISTING BY DOT CODE

INSTRUMENTATION TECHNOLOGY

POSSIBLE EXIT POINTS

	DOT DESCRIPTION	Instrumentation Technician	Test Technician	Calibration Laboratory Technician	Instrument Mechanic	Instrument Technician	Inspector	Inspector, Mechanical and Electrical	Instrument Mechanic	Tester, Electronic Scale	Inspector	Assembler	Calibrator	Instrument Technician Helper	Instrument Checker	Electrical - Instrument Repairer	Electrical - Equipment Tester
	DOT NO.	003.261-010	019.161-014	019.281-010	710.281-026	710.281-030	710.381-034	710.381-038	710.381-042	710.381-046	710.384-014	710.681-010	710.681-014	710.684-030	710.687-026	729.281-026	729.381-010
TASK NO.	TASK NAME																
POM-10	Identifying properties and applications of wood	X	X	X	X	X	X	X			X	X	X		X	X	X
POM-11	Identifying adhesives and tapes	X	X	X	X	X	X	X			X	X	X		X	X	X
POM-12	Identifying basic principles of lubrication	X	X	X	X	X	X	X			X	X	X		X	X	X
POM-13	Identifying oils and their applications	X	X	X	X	X	X	X			X	X	X		X	X	X
POM-14	Identifying general purpose greases	X	X	X	X	X	X	X			X	X	X		X	X	X
POM-15	Identifying lubricating compounds	X	X	X	X	X	X	X			X	X	X		X	X	X
POM-16	Identifying hydraulic fluids	X	X	X	X	X	X	X			X	X	X		X	X	X

TASK LISTING BY DOT CODE

INSTRUMENTATION TECHNOLOGY

POSSIBLE EXIT POINTS

	DOT NO.	003.261-010	019.161-014	019.281-010	710.281-026	710.281-030	710.381-034	710.381-038	710.381-042	710.381-046	710.384-014	710.681-010	710.681-014	710.684-030	710.687-026	729.281-026	729.381-010
	DOT DESCRIPTION	Instrumentation Technician	Test Technician	Calibration Laboratory Technician	Instrument Mechanic	Instrument Technician	Inspector	Inspector, Mechanical and Electrical	Instrument Mechanic	Tester, Electronic Scale	Inspector	Assembler	Calibrator	Instrument Technician Helper	Instrument Checker	Electrical - Instrument Repairer	Electrical - Equipment Tester
TASK NO.	TASK NAME																
	MANUFACTURING PROCESSES																
MFP-01	Identifying practical applications of power	X	X														
MFP-02	Identifying pneumatic principles	X	X														
MFP-03	Identifying reciprocating compressors	X	X														
MFP-04	Identifying rotary compressors	X	X														
MFP-05	Identifying primary air treatment in pneumatic systems	X	X														
MFP-06	Identifying secondary air treatment methods	X	X														
MFP-07	Identifying piping, hoses and fittings																

TASK LISTING BY DOT CODE

INSTRUMENTATION TECHNOLOGY

POSSIBLE EXIT POINTS

TASK NO.	TASK NAME	DOT NO. 003.261-010 Instrumentation Technician	019.161-014 Test Technician	019.281-010 Calibration Laboratory Technician	710.281-026 Instrument Mechanic	710.281-030 Instrument Technician	710.381-034 Inspector	710.381-038 Inspector, Mechanical and Electrical	710.381-042 Instrument Mechanic	710.381-046 Tester, Electronic Scale	710.384-014 Inspector	710.681-010 Assembler	710.681-014 Calibrator	710.684-030 Instrument Technician Helper	710.687-026 Instrument Checker	729.281-026 Electrical - Instrument Repairer	729.381-010 Electrical - Equipment Tester
	used in pneumatic systems	X	X														
MFP-08	Identifying control valves	X	X														
MFP-09	Identifying pressure relief valves	X	X														
MFP-10	Identifying cylinders	X	X														
MFP-11	Identifying motors	X	X														
MFP-12	Identifying components of pneumatic systems	X	X														
MFP-13	Reading pneumatic schematic diagrams	X	X														
MFP-14	Installing system components	X	X														
MFP-15	Identifying procedures for pneumatic system maintenance	X	X														
MFP-16	Determining system failures	X	X														

TASK LISTING BY DOT CODE

INSTRUMENTATION TECHNOLOGY

POSSIBLE EXIT POINTS

TASK NO.	TASK NAME	Instrumentation Technician 003.261-010	Test Technician 019.161-014	Calibration Laboratory Technician 019.281-010	Instrument Mechanic 710.281-026	Instrument Technician 710.281-030	Inspector 710.381-034	Inspector, Mechanical and Electrical 710.381-038	Instrument Mechanic 710.381-042	Tester, Electronic Scale 710.381-046	Inspector 710.384-014	Assembler 710.681-010	Calibrator 710.681-014	Instrument Technician Helper 710.684-030	Instrument Checker 710.687-026	Electrical - Instrument Repairer 729.281-026	Electrical - Equipment Tester 729.381-010
MFP-17	Troubleshooting air compressors	X	X														
MFP-18	Troubleshooting control valves	X	X														
MFP-19	Troubleshooting cylinders	X	X														
MFP-20	Troubleshooting air motors	X	X														
MFP-21	Troubleshooting a pneumatic and hydraulic system	X	X														
MFP-22	Identifying metal manufacturing processes	X	X														
MFP-23	Identifying strainers and filters in hydraulic systems	X	X														
MFP-24	Identifying reservoirs and accumulators in a hydraulic system	X	X														

TASK LISTING BY DOT CODE

INSTRUMENTATION TECHNOLOGY

POSSIBLE EXIT POINTS

TASK NO.	TASK NAME																
	DOT NO.	003.261-010	019.161-014	019.281-010	710.281-026	710.281-030	710.381-034	710.381-038	710.381-042	710.381-046	710.384-014	710.681-010	710.681-014	710.684-030	710.687-026	729.281-026	729.381-010
	DOT DESCRIPTION	Instrumentation Technician	Test Technician	Calibration Laboratory Technician	Instrument Mechanic	Instrument Technician	Inspector	Inspector, Mechanical and Electrical	Instrument Mechanic	Tester, Electronic Scale	Inspector	Assembler	Calibrator	Instrument Technician Helper	Instrument Checker	Electrical - Instrument Repairer	Electrical - Equipment Tester
MFP-25	Identifying hydraulic pumps on a system	X	X														
MFP-26	Identifying piping,tubing and fittings	X	X														
MFP-27	Identifying directional control valves	X	X														
MFP-28	Identifying pressure control valves	X	X														
MFP-29	Identifying cylinders in a hydraulic system	X	X														
MFP-30	Identifying hydraulic motors	X	X														
MFP-31	Troubleshooting hydraulic systems schematics	X	X														
MFP-32	Reading hydraulic schematic diagrams	X	X														
MFP-33	Installing hydraulic components	X	X														

TASK LISTING BY DOT CODE

INSTRUMENTATION TECHNOLOGY

POSSIBLE EXIT POINTS

TASK NO.	TASK NAME	Instrumentation Technician	Test Technician	Calibration Laboratory Technician	Instrument Mechanic	Instrument Technician	Inspector	Inspector, Mechanical and Electrical	Instrument Mechanic	Tester, Electronic Scale	Inspector	Assembler	Calibrator	Instrument Technician Helper	Instrument Checker	Electrical - Instrument Repairer	Electrical - Equipment Tester
	DOT NO.	003.261-010	019.161-014	019.281-010	710.281-026	710.281-030	710.381-034	710.381-038	710.381-042	710.381-046	710.384-014	710.681-010	710.681-014	710.684-030	710.687-026	729.281-026	729.381-010
MFP-34	Installing pipes and tubes	X	X														
MFP-35	Selecting hydraulic fluids	X	X														
MFP-36	Planning system maintenance	X	X														
MFP-37	Troubleshooting hydraulic systems (diagnostic technique)	X	X														
MFP-38	Troubleshooting valves	X	X														
MFP-39	Troubleshooting cylinders	X	X														
MFP-40	Troubleshooting pumps and motors	X	X														
MFP-41	Identifying basic packaging methods	X	X														
MFP-42	Identifying actuating mechanisms	X	X														
MFP-43	Identifying basic troubleshooting principles of packaging machinery	X	X														

TASK LISTING BY DOT CODE

INSTRUMENTATION TECHNOLOGY

POSSIBLE EXIT POINTS

TASK NO.	TASK NAME	DOT NO. 003.261-010 DOT DESCRIPTION Instrumentation Technician	019.161-014 Test Technician	019.281-010 Calibration Laboratory Technician	710.281-026 Instrument Mechanic	710.281-030 Instrument Technician	710.381-034 Inspector	710.381-038 Inspector, Mechanical and Electrical	710.381-042 Instrument Mechanic	710.381-046 Tester, Electronic Scale	710.384-014 Inspector	710.681-010 Assembler	710.681-014 Calibrator	710.684-030 Instrument Technician Helper	710.687-026 Instrument Checker	729.281-026 Electrical - Instrument Repairer	729.381-010 Electrical - Equipment Tester
MFP-44	Identifying mechanical drives	X	X														
MFP-45	Identifying motors and brakes	X	X														
MFP-46	Identifying electrical controls	X	X														
MFP-47	Identifying packaging materials	X	X														
MFP-48	Identifying methods of filling containers	X	X														
MFP-49	Identifying methods of sealing	X	X														
MFP-50	Identifying the processes used for heat treatment of material	X	X														
MFP-51	Identifying the processes used to produce plastics	X	X														
MFP-52	Identifying the processes used to																

TASK LISTING BY DOT CODE

INSTRUMENTATION TECHNOLOGY

TASK NO.	TASK NAME	POSSIBLE EXIT POINTS																
	DOT DESCRIPTION	Instrumentation Technician	Test Technician	Calibration Laboratory Technician	Instrument Mechanic	Instrument Technician	Inspector	Inspector, Mechanical and Electrical	Instrument Mechanic	Tester, Electronic Scale	Inspector	Assembler	Calibrator	Instrument Technician Helper	Instrument Checker	Electrical - Instrument Repairer	Electrical - Equipment Tester
	DOT NO.	003.261-010	019.161-014	019.281-010	710.281-026	710.281-030	710.381-034	710.381-038	710.381-042	710.381-046	710.384-014	710.681-010	710.681-014	710.684-030	710.687-026	729.281-026	729.381-010
	produce iron	X	X														
MFP-53	Identifying processes used to produce steel	X	X														
MFP-54	Identifying processes used to produce aluminum	X	X														
MFP-55	Identifying processes for the production of magnesium and titanium	X	X														
MFP-56	Identifying processes used to produce copper	X	X														
MFP-57	Identifying processes used to produce lead, nickel, tin and zinc	X	X														
MFP-58	Identifying common couplings	X	X														

TASK LISTING BY DOT CODE

INSTRUMENTATION TECHNOLOGY

POSSIBLE EXIT POINTS

TASK NO.	TASK NAME	003.261-010 Instrumentation Technician	019.161-014 Test Technician	019.281-010 Calibration Laboratory Technician	710.281-026 Instrument Mechanic	710.281-030 Instrument Technician	710.381-034 Inspector	710.381-038 Inspector, Mechanical and Electrical	710.381-042 Instrument Mechanic	710.381-046 Tester, Electronic Scale	710.384-014 Inspector	710.681-010 Assembler	710.681-014 Calibrator	710.684-030 Instrument Technician Helper	710.687-026 Instrument Checker	729.281-026 Electrical - Instrument Repairer	729.381-010 Electrical - Equipment Tester
MFP-59	Identifying clutches	X	X														
	IDENTIFICATION OF TEST INSTRUMENTS																
ITI-01	Identifying and using basic measuring instruments	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
ITI-02	Identifying and using volt-ohm milliammeters (VOM)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
ITI-03	Identifying and using electronic voltmeters (EVM)	X	X	X	X	X				X		X			X	X	X
ITI-04	Identifying and using ohmmeters	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
ITI-05	Identifying and using oscilloscopes	X	X	X	X	X		X		X					X		X

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INSTRUMENTATION TECHNOLOGY

POSSIBLE EXIT POINTS

	DOT DESCRIPTION	Instrumentation Technician	Test Technician	Calibration Laboratory Technician	Instrument Mechanic	Instrument Technician	Inspector	Inspector, Mechanical and Electrical	Instrument Mechanic	Tester, Electronic Scale	Inspector	Assembler	Calibrator	Instrument Technician Helper	Instrument Checker	Electrical - Instrument Repairer	Electrical - Equipment Tester
TASK NO.	TASK NAME / DOT NO.	003.261-010	019.161-014	019.281-010	710.281-026	710.281-030	710.381-034	710.381-038	710.381-042	710.381-046	710.384-014	710.681-010	710.681-014	710.684-030	710.687-026	729.281-026	729.381-010
ITI-06	Identifying and using tube testers	X	X	X	X	X											X
ITI-07	Identifying and using transistor analyzers	X	X	X	X	X											X
ITI-08	Identifying and using capacitor testers	X	X	X	X	X											X
ITI-09	Identifying and using sine wave generators	X	X	X	X	X							X		X		X
ITI-10	Identifying and using signal generators	X	X	X	X	X											X
ITI-11	Identifying and using pulse generators	X	X	X	X	X											X
ITI-12	Identifying and using square wave generators	X	X	X	X	X											X
ITI-13	Identifying and using impedance testers	X	X	X	X	X											X

TASK LISTING BY DOT CODE

INSTRUMENTATION TECHNOLOGY

POSSIBLE EXIT POINTS

TASK NO.	TASK NAME	DOT DESCRIPTION	Instrumentation Technician	Test Technician	Calibration Laboratory Technician	Instrument Mechanic	Instrument Technician	Inspector	Inspector, Mechanical and Electrical	Instrument Mechanic	Tester, Electronic Scale	Inspector	Assembler	Calibrator	Instrument Technician Helper	Instrument Checker	Electrical - Instrument Repairer	Electrical - Equipment Tester
		DOT NO.	003.261-010	019.161-014	019.281-010	710.281-026	710.281-030	710.381-034	710.381-038	710.381-042	710.381-046	710.384-014	710.681-010	710.681-014	710.684-030	710.687-026	729.281-026	729.381-010
ITI-14	Identifying and using frequency meters		X	X	X	X	X											
ITI-15	Using test instruments to measure voltage, current and resistance		X	X	X	X	X				X		X			X	X	X
ITI-16	Calculating values in DC network circuits		X	X	X	X	X				X		X			X	X	X
ITI-17	Calculating and measuring electrical values in AC capacitance circuits		X	X	X	X	X											X
ITI-18	Measuring inductance in series RL circuits		X	X	X	X	X											X
ITI-19	Calculating capacitance and time constants for RC circuits		X	X	X	X	X											X
ITI-20	Measuring AC values for LF circuits		X	X	X	X	X											X

TASK LISTING BY DOT CODE

INSTRUMENTATION TECHNOLOGY

POSSIBLE EXIT POINTS

	DOT NO.	003.261-010	019.161-014	019.281-010	710.281-026	710.281-030	710.381-034	710.381-038	710.381-042	710.381-046	710.384-014	710.681-010	710.681-014	710.684-030	710.687-026	729.281-026	729.381-010
	DOT DESCRIPTION	Instrumentation Technician	Test Technician	Calibration Laboratory Technician	Instrument Mechanic	Instrument Technician	Inspector	Inspector, Mechanical and Electrical	Instrument Mechanic	Tester, Electronic Scale	Inspector	Assembler	Calibrator	Instrument Technician Helper	Instrument Checker	Electrical - Instrument Repairer	Electrical - Equipment Tester
TASK NO.	TASK NAME																
	PHYSICAL PROPERTIES MEASUREMENTS																
PPM-01	Identifying the nature of force	X	X	X	X	X	X	X	X	X	X	X	X			X	X
PPM-02	Identifying physical properties of motion	X	X	X	X	X	X	X	X	X	X	X	X			X	X
PPM-03	Identifying principles of work and energy	X	X	X	X	X	X	X	X	X	X	X	X			X	X
PPM-04	Identifying principles of simple machines	X	X	X	X	X	X	X	X	X	X	X	X			X	X
PPM-05	Calculating area and volume	X	X	X	X	X	X	X	X	X	X	X	X			X	X
PPM-06	Identifying properties of friction	X	X	X	X	X	X	X	X	X	X	X	X			X	X

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INSTRUMENTATION TECHNOLOGY

POSSIBLE EXIT POINTS

	DOT NO.	003.261-010	019.161-014	019.281-010	710.281-026	710.281-030	710.381-034	710.381-038	710.381-042	710.381-046	710.384-014	710.681-010	710.681-014	710.684-030	710.687-026	729.281-026	729.381-010
	DOT DESCRIPTION	Instrumentation Technician	Test Technician	Calibration Laboratory Technician	Instrument Mechanic	Instrument Technician	Inspector	Inspector, Mechanical and Electrical	Instrument Mechanic	Tester, Electronic Scale	Inspector	Assembler	Calibrator	Instrument Technician Helper	Instrument Checker	Electrical - Instrument Repairer	Electrical - Equipment Tester
TASK NO.	TASK NAME																
	DC MEASUREMENT PRINCIPLES																
DCM-01	Understanding fundamentals of electrical theory and electrical measurement	X	X	X	X	X	X	X	X	X		X				X	X
DCM-02	Making calculations using Ohm's law	X	X	X	X	X	X	X	X	X		X				X	X
DCM-03	Measuring current in DC circuits	X	X	X	X	X	X	X	X	X		X				X	X
DCM-04	Measuring voltage in DC circuits	X	X	X	X	X	X	X	X	X		X				X	X
DCM-05	Calculating and measuring resistance in DC circuits	X	X	X	X	X	X	X	X	X		X				X	X
DCM-06	Calculating voltage, current and resistance in DC series circuits	X	X	X	X	X	X	X	X	X		X				X	X

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POSSIBLE EXIT POINTS

TASK NO.	TASK NAME	Instrumentation Technician 003.261-010	Test Technician 019.161-014	Calibration Laboratory Technician 019.281-010	Instrument Mechanic 710.281-026	Instrument Technician 710.281-030	Inspector 710.381-034	Inspector, Mechanical and Electrical 710.381-038	Instrument Mechanic 710.381-042	Tester, Electronic Scale 710.381-046	Inspector 710.384-014	Assembler 710.681-010	Calibrator 710.681-014	Instrument Technician Helper 710.684-030	Instrument Checker 710.687-026	Electrical - Instrument Repairer 729.281-026	Electrical - Equipment Tester 729.381-010
DCM-07	Calculating total voltage, total current and total resistance in DC parallel circuits	X	X	X	X	X	X	X	X	X		X				X	X
DCM-08	Calculating and measuring electrical quantities in combination DC circuits	X	X	X	X	X	X	X	X	X		X				X	X
DCM-09	Calculating power in DC circuits	X	X	X	X	X	X	X	X	X		X				X	X
DCM-10	Applying fundamentals of magnetism and electromagnetism	X	X	X	X	X	X	X	X	X		X				X	X
	LOW FREQUENCY MEASUREMENTS																
LFM-01	Calculating values for a right triangle	X	X	X	X	X	X	X					X		X	X	X

TASK LISTING BY DOT CODE

INSTRUMENTATION TECHNOLOGY

POSSIBLE EXIT POINTS

TASK NO.	TASK NAME	003.261-010 Instrumentation Technician	019.161-014 Test Technician	019.281-010 Calibration Laboratory Technician	710.281-026 Instrument Mechanic	710.281-030 Instrument Technician	710.381-034 Inspector	710.381-038 Inspector, Mechanical and Electrical	710.381-042 Instrument Mechanic	710.381-046 Tester, Electronic Scale	710.384-014 Inspector	710.681-010 Assembler	710.681-014 Calibrator	710.684-030 Instrument Technician Helper	710.687-026 Instrument Checker	729.281-026 Electrical - Instrument Repairer	729.381-010 Electrical - Equipment Tester
	DOT NO. / DOT DESCRIPTION																
LFM-02	Identifying the characteristics of AC sine waves	X	X	X	X	X	X	X					X		X	X	X
LFM-03	Computing turns, voltage, current and impedance ratios of transformers	X	X	X	X	X	X	X								X	X
LFM-04	Determining reactance and impedance of a capacitor in either series or parallel circuits	X	X	X	X	X	X	X								X	X
LFM-05	Drawing phasor diagrams and calculating operating values for series AC circuits	X	X	X	X	X	X	X								X	X
LFM-06	Drawing phasor diagrams and calculating operating values for parallel																

TASK LISTING BY DOT CODE

INSTRUMENTATION TECHNOLOGY

POSSIBLE EXIT POINTS

TASK NO.	TASK NAME	Instrumentation Technician	Test Technician	Calibration Laboratory Technician	Instrument Mechanic	Instrument Technician	Inspector	Inspector, Mechanical and Electrical	Instrument Mechanic	Tester, Electronic Scale	Inspector	Assembler	Calibrator	Instrument Technician Helper	Instrument Checker	Electrical - Instrument Repairer	Electrical - Equipment Tester
DOT NO.		003.261-010	019.161-014	019.281-010	710.281-026	710.281-030	710.381-034	710.381-038	710.381-042	710.381-046	710.384-014	710.681-010	710.681-014	710.684-030	710.687-026	729.281-026	729.381-010
	AC circuits	X	X	X	X	X	X	X								X	X
	HIGH FREQUENCY MEASUREMENT PRINCIPLES																
HFM-01	Understanding fundamentals of tuned AC circuits	X	X	X	X	X											
HFM-02	Understanding fundamentals of semiconductor materials	X	X	X	X	X											
HFM-03	Identifying symbols and electrical characteristics of tunnel, varactor and high frequency diodes	X	X	X	X	X											
HFM-04	Understanding the fundamentals of																

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POSSIBLE EXIT POINTS

	DOT DESCRIPTION	Instrumentation Technician	Test Technician	Calibration Laboratory Technician	Instrument Mechanic	Instrument Technician	Inspector	Inspector, Mechanical and Electrical	Instrument Mechanic	Tester, Electronic Scale	Inspector	Assembler	Calibrator	Instrument Technician Helper	Instrument Checker	Electrical - Instrument Repairer	Electrical - Equipment Tester
	DOT NO.	003.261-010	019.161-014	019.281-010	710.281-026	710.281-030	710.381-034	710.381-038	710.381-042	710.381-046	710.384-014	710.681-010	710.681-014	710.684-030	710.687-026	729.281-026	729.381-010
TASK NO.	TASK NAME																
	bipolar transistors and their electrical characteristics	X	X	X	X	X											
HFM-05	Performing condition tests of bipolar transistors	X	X	X	X	X											
HFM-06	Understanding the fundamentals of field effect transistors and their electrical characteristics	X	X	X	X	X											
HFM-07	Understanding the fundamentals of thyristors and their electrical characteristics	X	X	X	X	X											
HFM-08	Understanding fundamentals of integrated circuits	X	X	X	X	X											

TASK LISTING BY DOT CODE

INSTRUMENTATION TECHNOLOGY

POSSIBLE EXIT POINTS

	DOT DESCRIPTION	Instrumentation Technician	Test Technician	Calibration Laboratory Technician	Instrument Mechanic	Instrument Technician	Inspector	Inspector, Mechanical and Electrical	Instrument Mechanic	Tester, Electronic Scale	Inspector	Assembler	Calibrator	Instrument Technician Helper	Instrument Checker	Electrical - Instrument Repairer	Electrical - Equipment Tester
	DOT NO.	003.261-010	019.161-014	019.281-010	710.281-026	710.281-030	710.381-034	710.381-038	710.381-042	710.381-046	710.384-014	710.681-010	710.681-014	710.684-030	710.687-026	729.281-026	729.381-010
TASK NO.	TASK NAME																
HFM-09	Defining the operating values and applications of opto-electronic devices	X	X	X	X	X											
HFM-10	Identifying the component parts and operational characteristics of diode vacuum tubes	X	X	X	X	X											
HFM-11	Identifying the component parts and operating characteristics of triode vacuum tubes	X	X	X	X	X											
HFM-12	Identifying the component parts and operating characteristics of tetrode vacuum tubes	X	X	X	X	X											

TASK LISTING BY DOT CODE

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POSSIBLE EXIT POINTS

	DOT DESCRIPTION	Instrumentation Technician	Test Technician	Calibration Laboratory Technician	Instrument Mechanic	Instrument Technician	Inspector	Inspector, Mechanical and Electrical	Instrument Mechanic	Tester, Electronic Scale	Inspector	Assembler	Calibrator	Instrument Technician Helper	Instrument Checker	Electrical - Instrument Repairer	Electrical - Equipment Tester
	DOT NO.	003.261-010	019.161-014	019.281-010	710.281-026	710.281-030	710.381-034	710.381-038	710.381-042	710.381-046	710.384-014	710.681-010	710.681-014	710.684-030	710.687-026	729.281-026	729.381-010
TASK NO.	TASK NAME																
HFM-13	Identifying the component parts and operating characteristics of pentode vacuum tubes	X	X	X	X	X											
HFM-14	Performing condition testing of the thermal stability and operational parameters of a common-emitter amplifier circuit	X	X	X	X	X											
HFM-15	Performing condition testing of DC and audio amplifiers	X	X	X	X	X											
HFM-16	Defining electrical characteristics, applications and normal operational values of amplifiers	X	X	X	X	X											

TASK LISTING BY DOT CODE

INSTRUMENTATION TECHNOLOGY

POSSIBLE EXIT POINTS

TASK NO.	TASK NAME	003.261-010 Instrumentation Technician	019.161-014 Test Technician	019.281-010 Calibration Laboratory Technician	710.281-026 Instrument Mechanic	710.281-030 Instrument Technician	710.381-034 Inspector	710.381-038 Inspector, Mechanical and Electrical	710.381-042 Instrument Mechanic	710.381-046 Tester, Electronic Scale	710.384-014 Inspector	710.681-010 Assembler	710.681-014 Calibrator	710.684-030 Instrument Technician Helper	710.687-026 Instrument Checker	729.281-026 Electrical - Instrument Repairer	729.381-010 Electrical - Equipment Tester
	ELECTRICAL EQUIPMENT SERVICING																
EES-01	Performing a visual inspection of electronic equipment	X	X	X	X	X	X									X	X
EES-02	Cleaning electronic equipment	X	X	X	X	X	X									X	X
EES-03	Lubricating electronic equipment	X	X	X	X	X	X									X	X
EES-04	Inspecting and replacing power cords and distribution cables	X	X	X	X	X	X									X	X
EES-05	Inspecting and replacing vacuum tubes	X	X	X	X	X	X									X	X
EES-06	Inspecting and replacing transistors	X	X	X	X	X	X									X	X
EES-07	Inspecting and replacing IC units	X	X	X	X	X	X									X	X

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TASK NO.	TASK NAME	Instrumentation Technician	Test Technician	Calibration Laboratory Technician	Instrument Mechanic	Instrument Technician	Inspector	Inspector, Mechanical and Electrical	Instrument Mechanic	Tester, Electronic Scale	Inspector	Assembler	Calibrator	Instrument Technician Helper	Instrument Checker	Electrical - Instrument Repairer	Electrical - Equipment Tester
	DOT NO.	003.261-010	019.161-014	019.281-010	710.281-026	710.281-030	710.381-034	710.381-038	710.381-042	710.381-046	710.384-014	710.681-010	710.681-014	710.684-030	710.687-026	729.281-026	729.381-010
EES-08	Inspecting and replacing printed circuit (PC) boards	X	X	X	X	X	X									X	X
EES-09	Performing a proof of performance on electronic equipment	X	X	X	X	X	X									X	X
EES-10	Keeping records on maintenance of equipment	X	X	X	X	X	X									X	X
	DC TECHNIQUES																
DCT-01	Determining meter movement, sensitivity and resistance	X	X	X	X	X	X	X					X		X	X	X
DCT-02	Extending the current range of a																

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	meter movement	X	X	X	X	X	X	X					X		X	X	X
DCT-03	Extending the voltage range of a																
	meter movement	X	X	X	X	X	X	X					X		X	X	X
DCT-04	Performing a condition test of a																
	semi-conductor diode using an ohmmeter	X	X	X	X	X	X	X					X		X	X	X
	LOW FREQUENCY TECHNIQUES																
LFT-01	Testing an amplifier for																
	amplification	X	X	X	X	X	X	X					X		X	X	X
LFT-02	Testing and repairing the vacuum																
	tube amplifier	X	X	X	X	X	X	X					X		X	X	X

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POSSIBLE EXIT POINTS

	DOT NO.	003.261-010	019.161-014	019.281-010	710.281-026	710.281-030	710.381-034	710.381-038	710.381-042	710.381-046	710.384-014	710.681-010	710.681-014	710.684-030	710.687-026	729.281-026	729.381-010
	DOT DESCRIPTION	Instrumentation Technician	Test Technician	Calibration Laboratory Technician	Instrument Mechanic	Instrument Technician	Inspector	Inspector, Mechanical and Electrical	Instrument Mechanic	Tester, Electronic Scale	Inspector	Assembler	Calibrator	Instrument Technician Helper	Instrument Checker	Electrical - Instrument Repairer	Electrical - Equipment Tester
TASK NO.	TASK NAME																
LFT-03	Testing and repairing a transistor amplifier	X	X	X	X	X	X	X					X		X	X	X
LFT-04	Identifying component parts and electrical characteristics of power supply circuits	X	X	X	X	X	X	X					X		X	X	X
LFT-05	Testing and repairing power supplies	X	X	X	X	X	X	X					X		X	X	X
	HIGH FREQUENCY TECHNIQUES																
HFT-01	Testing and repairing oscillators	X	X	X	X	X											
HFT-02	Testing and repairing clampers	X	X	X	X	X											
HFT-03	Testing and repairing clipper circuits	X	X	X	X	X											

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POSSIBLE EXIT POINTS

TASK NO.	TASK NAME	Instrumentation Technician	Test Technician	Calibration Laboratory Technician	Instrument Mechanic	Instrument Technician	Inspector	Inspector, Mechanical and Electrical	Instrument Mechanic	Tester, Electronic Scale	Inspector	Assembler	Calibrator	Instrument Technician Helper	Instrument Checker	Electrical - Instrument Repairer	Electrical - Equipment Tester
	DOT NO.	003.261-010	019.161-014	019.281-010	710.281-026	710.281-030	710.381-034	710.381-038	710.381-042	710.381-046	710.384-014	710.681-010	710.681-014	710.684-030	710.687-026	729.281-026	729.381-010
HFT-04	Testing and repairing counters	X	X	X	X	X											
HFT-05	Constructing oscillators and performing a condition test of the oscillators	X	X	X	X	X											
HFT-06	Constructing and performing condition tests of pulse circuits	X	X	X	X	X											
HFT-07	Testing and repairing non-sinusoidal amplifiers	X	X	X	X	X											
HFT-08	Troubleshooting sweep-generator circuits	X	X	X	X	X											
HFT-09	Troubleshooting electronic circuits	X	X	X	X	X											
HFT-10	Performing a condition test of																

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TASK NO.	TASK NAME	Instrumentation Technician	Test Technician	Calibration Laboratory Technician	Instrument Mechanic	Instrument Technician	Inspector	Inspector, Mechanical and Electrical	Instrument Mechanic	Tester, Electronic Scale	Inspector	Assembler	Calibrator	Instrument Technician Helper	Instrument Checker	Electrical - Instrument Repairer	Electrical - Equipment Tester
	DOT NO.	003.261-010	019.161-014	019.281-010	710.281-026	710.281-030	710.381-034	710.381-038	710.381-042	710.381-046	710.384-014	710.681-010	710.681-014	710.684-030	710.687-026	729.281-026	729.381-010
	zener diodes used in regulator																
	circuits	X	X	X	X	X											
	CALIBRATION OF TEST INSTRUMENTS																
CTI-01	Performing condition test and																
	calibration of volt-ohm-milliam-																
	meter (VOM)	X		X	X	X											
CTI-02	Performing condition test and																
	calibration of electrical																
	voltmeters (EVM)	X		X	X	X											
CTI-03	Performing condition test and																

TASK LISTING BY DOT CODE

INSTRUMENTATION TECHNOLOGY

POSSIBLE EXIT POINTS

TASK NO.	TASK NAME	003.261-010	019.161-014	019.281-010	710.281-026	710.281-030	710.381-034	710.381-038	710.381-042	710.381-046	710.384-014	710.681-010	710.681-014	710.684-030	710.687-026	729.281-026	729.381-010
DOT NO.	DOT DESCRIPTION	Instrumentation Technician	Test Technician	Calibration Laboratory Technician	Instrument Mechanic	Instrument Technician	Inspector	Inspector, Mechanical and Electrical	Instrument Mechanic	Tester, Electronic Scale	Inspector	Assembler	Calibrator	Instrument Technician Helper	Instrument Checker	Electrical - Instrument Repairer	Electrical - Equipment Tester
	calibration of tube testers	X		X	X	X											
CTI-04	Performing condition test and calibration of a transistor tester	X		X	X	X											
CTI-05	Performing condition test and calibration of resistor substitution box	X		X	X	X											
CTI-06	Performing condition test and calibration of oscilloscopes	X		X	X	X											
CTI-07	Performing condition test and calibration of sine wave generators	X		X	X	X											
CTI-08	Performing condition test and calibration of square wave and																

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POSSIBLE EXIT POINTS

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	pulse generators	X		X	X	X											
CTI-09	Performing condition test and																
	calibration of frequency meters	X		X	X	X											
CTI-10	Calibrating power supply voltage	X		X	X	X											
	SERVICING INSTRUMENTATION SYSTEMS																
SIS-01	Identifying automatic control																
	system functions	X	X		X	X								X			
SIS-02	Identifying the elements of process																
	control	X	X		X	X								X			
SIS-03	Identifying system transmitters and																

TASK LISTING BY DOT CODE

INSTRUMENTATION TECHNOLOGY

POSSIBLE EXIT POINTS

TASK NO.	TASK NAME	Instrumentation Technician 003.261-010	Test Technician 019.161-014	Calibration Laboratory Technician 019.281-010	Instrument Mechanic 710.281-026	Instrument Technician 710.281-030	Inspector 710.381-034	Inspector, Mechanical and Electrical 710.381-038	Instrument Mechanic 710.381-042	Tester, Electronic Scale 710.381-045	Inspector 710.384-014	Assembler 710.681-010	Calibrator 710.681-014	Instrument Technician Helper 710.684-030	Instrument Checker 710.687-026	Electrical - Instrument Repairer 729.281-026	Electrical - Equipment Tester 729.381-010
	receivers process loops	X	X		X	X								X			
SIS-04	Identifying diagram symbols and																
	networks	X	X		X	X								X			
SIS-05	Identifying parameters of an																
	operational process control system	X	X		X	X								X			
SIS-06	Identifying measurement purpose																
	and requirements	X	X		X	X								X			
SIS-07	Identifying the elements of																
	measurement systems	X	X		X	X								X			
SIS-08	Identifying measurement transducers	X	X		X	X								X			
SIS-09	Identifying instrument calibration																
	standards units	X	X		X	X								X			

TASK LISTING BY DOT CODE

INSTRUMENTATION TECHNOLOGY

POSSIBLE EXIT POINTS

TASK NO.	TASK NAME	Instrumentation Technician	Test Technician	Calibration Laboratory Technician	Instrument Mechanic	Instrument Technician	Inspector	Inspector, Mechanical and Electrical	Instrument Mechanic Tester, Electronic Scale	Inspector	Assembler	Calibrator	Instrument Technician Helper	Instrument Checker	Electrical - Instrument Repairer	Electrical - Equipment Tester
DOT NO.		003.261-010	019.161-014	019.281-010	710.281-026	710.281-030	710.381-034	710.381-038	710.381-042	710.381-046	710.384-014	710.681-010	710.681-014	710.684-030	710.687-026	729.281-026	729.381-010
SIS-10	Analyzing systems using trouble-shooting flow sheet	X	X		X	X								X			
SIS-11	Identifying pressure principles	X	X		X	X											
SIS-12	Identifying pressure sensors	X	X		X	X											
SIS-13	Identifying pressure transducers	X	X		X	X											
SIS-14	Identifying low pressure measurement gage requirements	X	X		X	X											
SIS-15	Installing and servicing pressure instruments	X	X		X	X											
SIS-16	Identifying force, stress and strain measurement units	X	X		X	X											
SIS-17	Identifying weight and mass																

TASK LISTING BY DOT CODE

INSTRUMENTATION TECHNOLOGY

POSSIBLE EXIT POINTS

	DOT DESCRIPTION	Instrumentation Technician	Test Technician	Calibration Laboratory Technician	Instrument Mechanic	Instrument Technician	Inspector	Inspector, Mechanical and Electrical	Instrument Mechanic	Tester, Electronic Scale	Inspector	Assembler	Calibrator	Instrument Technician Helper	Instrument Checker	Electrical - Instrument Repairer	Electrical - Equipment Tester
	DOT NO.	003.261-010	019.161-014	019.281-010	710.281-026	710.281-030	710.381-034	710.381-038	710.381-042	710.381-046	710.384-014	710.681-010	710.681-014	710.684-030	710.687-026	729.281-026	729.381-010
TASK NO.	TASK NAME																
	measuring instruments	X	X		X	X											
SIS-18	Identifying methods for weighing material in motion	X	X		X	X											
SIS-19	Identifying displacement measurement methods	X	X		X	X											
SIS-20	Identifying acceleration, vibration and shock measurement methods	X	X		X	X											
SIS-21	Identifying the properties of fluid flow measurement	X	X		X	X											
SIS-22	Identifying primary measuring devices for fluid flow	X	X		X	X											
SIS-23	Identifying secondary measuring																

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POSSIBLE EXIT POINTS

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SIS-24	Identifying applications for variable area instruments	X	X		X	X											
SIS-25	Identifying open channel flow devices	X	X		X	X											
SIS-26	Identifying applications for positive displacement meters	X	X		X	X											
SIS-27	Identifying applications for turbine and magnetic flow meters	X	X		X	X											
SIS-28	Identifying types of fluid flow meters	X	X		X	X											
SIS-29	Identifying solid particles flow																

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SIS-30	Installing and maintaining flow instruments	X	X		X	X											
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SIS-32	Identifying pressure head instruments	X	X		X	X											
SIS-33	Identifying electrical methods for level measurement	X	X		X	X											
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INSTRUMENTATION TECHNOLOGY

POSSIBLE EXIT POINTS

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	DOT NO.	003.261-010	019.161-014	019.281-010	710.281-026	710.281-030	710.381-034	710.381-038	710.381-042	710.381-046	710.384-014	710.681-010	710.681-014	710.684-030	710.687-026	729.281-026	729.381-010
SIS-36	Identifying temperature measurement principles	X	X		X	X											
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SIS-38	Identifying instruments using electrical methods of measuring temperature	X	X		X	X											
SIS-39	Identifying pyrometers	X	X		X	X											
SIS-40	Performing temperature measuring instrument maintenance and calibration	X	X		X	X											

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SIS-42	Identifying electric activators	X	X		X	X											
SIS-43	Identifying pneumatic and hydraulic activators	X	X		X	X											
SIS-44	Identifying control valves	X	X		X	X											
SIS-45	Identifying control element applications	X	X		X	X											
SIS-46	Identifying on-site safety standards and maintenance practices	X	X		X												
SIS-47	Identifying servicing requirements	X	X		X												
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TASK LISTING BY DOT CODE

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POSSIBLE EXIT POINTS

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TASK NO.	TASK NAME																
	electronic stations	X	X		X	X											
SIS-49	Detailing pneumatic and hydraulic stations	X	X		X	X											
SIS-50	Detailing troubleshooting requirements	X	X		X	X											
	DESIGNING AND MODIFYING SYSTEMS																
DMS-01	Designing voltage amplifiers	X	X		X	X											
DMS-02	Designing wave shaping circuits	X	X		X	X											
DMS-03	Designing logic circuits	X	X		X	X											
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TASK NO.	TASK NAME																
DMS-05	Laying out, taping up and drawing basic printed circuit boards	X	X			X											
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DMS-07	Modifying circuits to accommodate integrated circuits (IC)	X	X			X											
DMS-08	Preparing assembly guides	X	X			X											
DMS-09	Preparing parts lists	X	X			X											
DMS-10	Making truth tables for logic gates	X	X			X											

SECTION III

UNIT GUIDES

SECTION III

Section III Content List

Unit Guide Description
Suggested Sequence of Unit Guides

In Section II, the relationship between the occupational area and program tasks was introduced. Section III continues this development by presenting, for each task, a unit guide for instructional planning and execution.

The instruction of specific tasks is central to vocational education. However, the value of a single task/competency to the student as a prospective member of the workforce is dependent upon the way in which that task/competency is related to other tasks and to the entire occupational area. Therefore, the Instrumentation Technology Program Task Listing provides a sample organizational model for sequencing the instruction of program tasks.

UNIT GUIDES DESCRIPTION

In this section the tasks to be taught in each course are presented in sequential order. Each task is listed on a separate page so that it may be taken out of the guide for daily lesson planning or regrouped with order tasks to fit the individual teacher's preference for teaching order. The task pages may be used for planning and executing group instruction or for individualized instruction. Each page in the UNIT GUIDES section contains the following information:

TASK: This is a short and concise statement of the task to be taught.

PERFORMANCE OBJECTIVE: The performance expected of the student after completing the unit is stated in stem form, without a specific statement of all conditions, equipment and performance standard (these are listed in a criterion referenced measure in the Evaluation section of the task page).

INSTRUCTIONAL ACTIVITIES: Suggested learning activities are presented. These activities include providing information, demonstration, practical applications and projects.

INSTRUCTIONAL MATERIALS: Suggested materials for carrying out the instructional activities are listed. these include textbooks, audiovisuals and equipment. Textbooks are referenced by author and title with the complete reference contained in the textbook list in the Instructional Resources section.

EVALUATION: This section contains a criterion referenced measure and reference to any test items or other evaluation measures that are available to teacher.

CLASS/LAB HOURS: The estimated time for completion of the instructional activities and the evaluation are indicated in both classroom and lab hours. Total instructional time would be the sum of these.

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TASK

SPT-01 Identifying plant safety procedures

PERFORMANCE OBJECTIVE

Identify general plant safety procedures and locate and correct safety hazards.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Who is responsible for safety
b. Accidents and injuries
c. The accident chain
d. Built-in hazards
e. Human influences on safety

Provide Practical Application On:

Identifying dangerous conditions in the shop

INSTRUCTIONAL MATERIALS

Textbooks:

AAVIM, Developing Shop Safety Skills

A/Vs:

a. AAVIM, "Developing Shop Safety," slide/tape
b. Career Aids, Inc., "Safetitudes," filmstrip/tapes and "General Shop Safety," filmstrips/tapes

Student Manuals:

a. Plant Engineering Training Systems, Plant Safety, Lesson One
b. AAVIM, Developing Shop Safety Skills

LAB HOURS	1
CLASS HOURS	2

EVALUATION (SPT-01)

Given a safety hazard in the shop, the student will locate the safety hazard and correct the situation according to the instructor's specifications.

TASK

SPT-02 Observing safety precautions for tools and equipment

PERFORMANCE OBJECTIVE

Observe all safety precautions when using tools and equipment.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Hand tools
   1. Defective tools
   2. Using wrong tool
   3. Right tool, wrong method
   4. Improper tool maintenance
b. Built-in hazards
c. Powered hand tools
d. Pneumatic tools
e. Tool bit safety
f. Gasoline powered tools
g. Explosive powered tools
h. Portable ladders
i. Step ladders
j. Ladder safety

(Continued on back)

Provide Practical Application On:

Describing the safety precautions for using tools in the shop/plant

INSTRUCTIONAL MATERIALS

A/Vs:

a. Hobar, SMP-II, SMP-III and SMP-IV, slide sets and "Power Tool Safety and Operations," transparencies
b. Career Aids, Inc., "Using Hand Tools: Parts A and B," filmstrips/tapes and "Using Power Tools," filmstrips/tapes

Student Manuals:

a. Plant Engineering Training Systems, Plant Safety, Lesson Four
b. Hobar, Power Tool Safety and Operation

Tools and Equipment:

Selection of shop tools

LAB HOURS	1
CLASS HOURS	2

EVALUATION (SPT-02)

Given a selection of shop tools, the student will describe procedures for the safe use of tools.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

k. Fixed ladders
l. Ladder inspection
m. Scaffolds and working platforms

TASK

SPT-03 Identifying machinery safeguards

PERFORMANCE OBJECTIVE

Identify safeguards when operating machinery.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Machine guards
b. Hazardous motions
    1. High speed rotating parts which appear to stand still
    2. Inrunning nip points
c. Locking out power
d. Locking moving parts
e. Point of operation machinery guarding
f. Barrier and enclosure guards
g. Controls and operating safety
h. Mechanical power transmission guards

Provide Practical Application On:

Describing safety procedures for power tools in the shop

INSTRUCTIONAL MATERIALS

A/Vs:

Hobar, "Power Tool Safety and Operation," transparencies

Student Manuals:

a. Plant Engineering Training Systems, *Plant Safety, Lesson Five*
b. Hobar, *Power Tool Safety and Operation*

Tools and Equipment:

Selection of power tools

LAB HOURS	1
CLASS HOURS	2

EVALUATION (SPT-03)

Given a series of power tools in the shop, the student will identify and describe the safety precautions for each machine according to the instructor's specifications.

TASK

SPT-04 Observing safety in handling materials

PERFORMANCE OBJECTIVE

Observe all safety precautions when handling materials using the lift-and-carry procedures.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Material handling injuries
   1. Causes
   2. Avoiding injuries
b. Manual lifting, carrying, setting
c. Built-in material hazards
d. Team handling
e. Handling special shapes and sizes
f. Hand tools and accessories
g. Hand trucks, dollies, wheelbarrows
h. Powered industrial trucks
i. Conveyors, chutes, troughs
j. Joists and cranes
k. Receiving and storage

(Continued on back)

Provide Practical Application On:

Following all safety rules, lift an object (crate or similar) and carry and set it in place.

INSTRUCTIONAL MATERIALS

A/Vs:

Career Aids, Inc., "Lift with Your Head," filmstrip/tape

Student Manuals:

Plant Engineering Training Systems, Plant Safety, Lesson Three

Tools and Equipment:

Crates or other objects to lift

LAB HOURS	1
CLASS HOURS	2

EVALUATION (SPT-04)

Given an object, the student will lift, carry and set the object in a designated location. The procedure must be in accordance with the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

l. Storage safety
m. Chemicals and flammable materials
n. Materials handling and lighting

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TASK

SPT-05 Identifying work area safety precautions

PERFORMANCE OBJECTIVE

Identify safety precautions for the work area and be able to correct the situation.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Hazards
    1. Mechanical
    2. Electrical
    3. Chemical
    4. Environmental
b. Built-in hazards
c. Moving machinery
d. Plant traffic
e. Safety at heights
f. Safety in extreme heat
g. Enclosed areas
h. Flammability and toxicity problems
i. Chemical safety
j. Utility maintenance safety
k. Radiation

Provide Practical Application On:

Identifying safety hazards in the work area

INSTRUCTIONAL MATERIALS

A/Vs:

Career Aids, Inc., "Safety at Work," filmstrips/tapes

Student Manuals:

Plant Engineering Training Systems, *Plant Safety, Lesson Two*

LAB HOURS	1
CLASS HOURS	2

EVALUATION (SPT-05)

Given a safety hazard in the work area, the student will identify the hazard and correct the situation according to the instructor's specifications.

TASK

SPT-06 Identifying fire prevention procedures

PERFORMANCE OBJECTIVE

Identify procedures for fire prevention.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. How fires start
   1. Fuel, heat, oxygen
   2. Spontaneous combustion
   3. External ignition
   4. Flash point
b. Volatile liquids, materials
   1. Gasoline
   2. Fuel oils
   3. Carbon monoxide
   4. Dusts, powders
c. Ordinary combustibles
d. Fire prevention
e. Four classes of fire
   1. Class A-ordinary combustibles - extinguishers

(Continued on back)

Provide Practical Application On:

Choosing the correct fire extinguisher

INSTRUCTIONAL MATERIALS

Textbooks:

Colburn, Fire Protection and Suppression

A/Vs:

Career Aids, Inc., "School Shop Safety," filmstrip/tape

Student Manuals:

Plant Engineering Training Systems, Plant Safety, Lesson Nine

Tools and Equipment:

Four types of fire extinguishers

LAB HOURS	1
CLASS HOURS	2

EVALUATION (SPT-06)

Given a description of a fire, the student will correctly choose the type of fire extinguisher which will safely extinguish the fire. The student will also accurately identify fire prevention procedures.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

2. Class B-flammable liquids-extinguishers
3. Class C-electrical equipment-extinguishers
4. Class D-combustible metals-extinguishers

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TASK

SPT-07 Handling hazardous materials

PERFORMANCE OBJECTIVE

Observe safety precautions when handling hazardous materials.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Materials hazards and injuries
    1. Inhaling
    2. Ingestion
    3. Absorption
b. Hazardous liquids
c. Using solvents
    1. Flash point
    2. Ventilation
d. Packaged materials
e. Normal exposure cautions
f. Sudden, unexpected explosure
g. Noise hazards
h. Welding hazards
i. Welding safety

Provide Demonstration On:

Handling solvents

INSTRUCTIONAL MATERIALS

Textbooks:

Anton, Occupational Safety and Health Management

A/Vs:

Career Aids, Inc., "Safety at Work," filmstrip/tape

Student Manuals:

Plant Engineering Training Systems, Plant Safety, Lesson Eight

Tools and Equipment:

a. Solvents
b. Fuel cans
c. Other hazardous materials

LAB HOURS	1
CLASS HOURS	2

EVALUATION (SPT-07)

Given a selection of hazardous materials in the shop, the student will identify the materials and describe the necessary related safety precautions according to the instructor's specifications.

TASK

SPT-08 Observing electrical safety precautions

PERFORMANCE OBJECTIVE

Observe all precautions for electrical safety.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

- a. Basic electricity
  - 1. Amperes
  - 2. Volts
  - 3. Ohm
  - 4. Ohm's law
  - 5. Short circuit
- b. Electrical injuries
- c. Preventing electrical accidents
- d. Overcurrent protection
  - 1. Fuses
  - 2. Circuit breakers
- e. Grounding
  - 1. Ground faults
  - 2. GFC
- f. Hazardous location
- g. Double insulated tools
- h. General electrical safety rules

Provide Demonstration On:

Procedures for treating shock

Provide Practical Application On:

Developing a safety checklist

INSTRUCTIONAL MATERIALS

A/Vs:

Career Aids, Inc., "Electrical Safety in the Shop," filmstrip/tape and "Electricity/Electronics," filmstrip/tape

Student Manuals:

- a. Heathkit, DC Electronics, Student Workbook
- b. Georgia, Electronics Technology, Phase A, Unit 3-A
- c. MAVCC, Basic Electronics I

LAB HOURS 1

CLASS HOURS 2

EVALUATION (SPT-08)

a. Given electrical safety rules for the shop, the student will identify and describe electrical procedures and devices according to the instructor's specifications.

b. Heathkit, DC Electronics, Student Workbook.

c. MAVCC, Basic Electronics 1.

d. Georgia, Electronics Technology, Phase A, Student Tests.

TASK

SPT-09 Identifying personal protection gear

PERFORMANCE OBJECTIVE

Identify gear for personal protection.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Head protection
b. Eye protection
c. Face shields
d. Face and body shields
e. Ear protection
f. Foot protection
g. Respiratory protection
h. Processing air for respiration
i. Safety harnesses and lifelines
j. Gloves and special work clothes

Provide Demonstration On:

How to use a gas mask

Provide Practical Application On:

Selecting proper safety devices for assigned jobs

INSTRUCTIONAL MATERIALS

Textbooks:

Dover Publications, Inc., Tools and Their Uses

A/Vs:

Career Aids, "General Shop Safety," filmstrip

Student Manuals:

Plant Engineering Training Systems, Plant Safety, Lesson Six

Tools and Equipment:

Selection of safety equipment
1. Hard hats
2. Steel toes
3. Face shields
4. Goggles
5. Safety glasses
6. Gas mask

LAB HOURS	1
CLASS HOURS	2

EVALUATION (SPT-09)

Given an assigned job in the shop, the student will choose the appropriate personal safety devices for the job according to the instructor's specifications.

TASK

SPT-10 Identifying and using hand tools

PERFORMANCE OBJECTIVE

Identify and use hand tools.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Screwdrivers
   1. Flat blade
   2. Phillips
   3. Socket head
   4. Offset

b. Parts of a screwdriver
   1. Blade
   2. Handle
   3. Shank

c. Safety
   1. Matching blade to screw head
   2. Keeping blade ends ground flat and square
   3. Handles free of oil, grease
   4. Should not be used as punch or chisel
   5. Should not be used as pliers or wrenches
   6. Using the screwdriver with the blade from the body

d. Hammers
   1. Carpenter's hammer (claw)
   2. Machinist hammer (ball peen)
   3. Soft face hammers

e. Hammer safety
   1. Keeping the hammer free of oil or grease
   2. Never leaving a hammer on a ladder

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

Dover Publications, Inc., Tools and Their Uses

A/Vs:

a. Hobar, "Hammer, Nails and Nailing Techniques," slide/tape and "Screws and Driving Tools," slide/tape

b. Career Aids, Inc., "Using Hand Tools, Part 1," and "Using Hand Tools, Part 2," transparencies

Student Manuals:

Plant Engineering Training Systems, Elements of Mechanics, Lesson Seven

Tools and Equipment:

a. Screwdrivers
b. Hammers
c. Chisels
d. Hacksaws
e. Wrenches

(Continued on back)

LAB HOURS	1
CLASS HOURS	2

EVALUATION (SPT-10)

Given a job, the student will identify the correct tools for the job and use the tools in the appropriate manner. The completed job must be in compliance with industry requirements.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

f. Wrenches
    1. Adjustable end wrench
    2. Pipe wrench
    3. Open end wrench
    4. Box end wrench
    5. Combination wrenches
    6. Socket wrenches, ratchet handle and speed handle
    7. Torque wrench
    8. Safety
g. Pliers
    1. Slip-joint pliers
    2. Water-pump pliers
    3. Grooved or arc joint pliers
    4. Locking pliers
    5. Safety
h. Hacksaws
i. Punches and chisels
    1. Center punch
    2. Aligning punch
    3. Drift punch
    4. Gasket punch
j. Drills
k. Flies
l. Tin snips
m. Taps and dies
    1. Taper
    2. Plug
    3. Bottoming
    4. T-handle
    5. Straight handle

INSTRUCTIONAL MATERIALS

Tools and Equipment:

f. Pliers
g. Drills
h. Taps and dies

TASK

SPT-11 Identifying and using power tools

PERFORMANCE OBJECTIVE

Identify and use power tools.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Safe use of portable power tools
    1. Personal safety
    2. Electrical safety
b. Hand drill
    1. Chuck
    2. Drill safety
c. Drill press
    1. Safety
    2. Drill bit selection
    3. Work holding devices
    4. Center drilling
d. Bench grinders
    1. Safety
    2. Dressing the wheel
    3. Types of work

INSTRUCTIONAL MATERIALS

Textbooks:

Dover Publications, Inc., Tools and Their Uses

A/Vs:

Hobar, "Safety: Machine and Power Tools," transparencies

Student Manuals:

Plant Engineering Training Systems, Elements of Mechanics, Lesson Eight

Tools and Equipment:

a. Drills
b. Drill press
c. Bench grinder

LAB HOURS	1
CLASS HOURS	4

EVALUATION (SPT-11)

Given a selection of power tools, the student will accurately identify each tool, describe its use and identify safety rules for operation of the tool. The following tools will be used:

1. Drills
2. Drill press
3. Bench grinder

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TASK

SPT-12 Identifying types of fasteners

PERFORMANCE OBJECTIVE

Identify types of fasteners and their applications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Bolt failure
b. Screw threads
    1. Helix
    2. External or internal
    3. Root
    4. Crest
    5. Pitch
    6. Lead
    7. Thread angle
    8. Reason for different types of threads
c. Screw thread specifications
    1. Thread diameter
    2. Threads per inch
    3. Thread type
    4. External threads-1A, 2A and 3A
    5. Internal threads-1B, 2B and 3B
d. Reading thread specifications
e. Threaded fasteners
    1. Bolt
    2. Stud
    3. Cap screw
    4. Machine screw
    5. Set screw
f. Nuts
g. Washers
    1. Flat
    2. Conical
    3. Helical spring
    4. Spring washers
    5. Tooth lock washers
h. Rivets

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

Dover, Tools and Their Uses

Student Manuals:

Plant Engineering Training System, Elements of Mechanics, Lesson Nine

Tools and Equipment:

Several types of fasteners

LAB HOURS 1

CLASS HOURS 1

EVALUATION (SPT-12)

Given a selection of fasteners, the student will accurately identify the type of fastener and describe its application.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

i. Pin fasteners
j. Keys
    1. Keystock
    2. Gib-head
k. Special purpose fasteners
    1. Self-tapping screws
    2. Locking nut fasteners
    3. Self-retaining nuts
    4. Plate or anchor nuts
    5. Caged nuts
    6. Clinch nuts
    7. Self-piercing nuts
l. Corrosion
    1. Direct attack
    2. Galvanic corrosion
    3. Concentration cell
    4. Fretting
    5. Oxidation
    6. Stress corrosion cracking
    7. Corrosion fatigue

TASK

SPT-13 Identifying and using wrenches and screwdrivers

PERFORMANCE OBJECTIVE

Identify and use wrenches and screwdrivers.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Wrenches
    1. Materials
    2. Uses
    3. Tolerance
b. Types of wrenches
    1. Open-end
    2. Box-end
    3. Combination
    4. Socket, socket handles
    5. Torque wrenches
    6. Socket head, Allen wrenches
c. Using wrenches
d. Screwdrivers
    1. Types of screwdrivers
    2. Dressing the blade

(Continued on back)

Provide Demonstration On:

a. Proper use of a torque wrench
b. Dressing the blade of a screwdriver

Provide Practical Application On:

a. Using several types of wrenches
b. Using several types of screwdrivers

INSTRUCTIONAL MATERIALS

Textbooks:

a. Dover Publications, Tools and Their Uses
b. Hobar, Screwdrivers

A/Vs:

Hobar, "Screws and Driving Tools," slide/tape and "Torque and Torque Wrenches," transparencies

Student Manuals:

Plant Engineering Training Systems, Hand Tools, Lesson Two

Tools and Equipment:

a. Assortment of wrenches
b. Assortment of screwdrivers

LAB HOURS	1
CLASS HOURS	2

EVALUATION (SPT-13)

Given a job which requires the use of wrenches, torque wrenches and screwdrivers, the student will select the appropriate tools and use them according to correct and safe procedures.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

3. Driving and drawing a screw
4. Care, use and screwdriver safety

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TASK

SPT-14 Identifying and using pipefitting tools

PERFORMANCE OBJECTIVE

Identify and use pipefitting tools.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Uses of pipe
b. Pipe wrenches
   1. Straight
   2. Stillson
c. How to use pipe wrenches
d. Compound cleverage wrench
e. Strap wrench
f. Chain pipe wrench
g. Cutting pipe
h. Pipe vises
i. Threading and tapping pipes
j. Reaming
k. Tubing and plastic pipe cutters
l. Flaring tools

(Continued on back)

Provide Demonstration On:

The proper way to hold and use a pipe wrench

Provide Practical Application On:

Tightening a pipe fitting with a pipe wrench

INSTRUCTIONAL MATERIALS

Textbooks:

Dover Publications, *Tools and Their Uses*

Student Manuals:

Plant Engineering Training Systems, *Hand Tools, Lesson Three*

Tools and Equipment:

a. Several types of pipe wrenches
b. Pipes and fittings

LAB HOURS 1

CLASS HOURS 2

EVALUATION (SPT-14)

Given a pipe fitting, the student will select the appropriate pipe wrench from the tool room and tighten the fitting using the proper technique. The completed task must comply with the instructor's specifications.

INSTRUCTIONAL ACTIVITIES:

Provide Information On:

m. Pipe tool care
    1. Cleaning and storage
    2. Lubricating
    3. Maintaining

TASK

SPT-15 Identifying and using plumbing tools

PERFORMANCE OBJECTIVE

Identify and use plumbing tools.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Three basic areas of plumbing
    1. Water supply
    2. Drainage
    3. Fixtures
b. Plumbing codes
c. The plumbing system
d. The water supply system
e. Tube bending
    1. Tools
    2. Procedure
f. Cutting cast iron sail pipe
g. Using sail pipe assembly tool
h. Force-up plungers

(Continued on back)

Provide Demonstration On:

a. Bending tube
b. Measuring pipe

Provide Practical Application On:

a. Using a tube bender to bend tube
b. Measuring a length of pipe

INSTRUCTIONAL MATERIALS

Textbooks:

a. Dover Publications, Tools and Their Uses
b. Audel, Plumbers and Pipefitter's Library

Student Manuals:

a. Plant Engineering Training Systems, Hand Tools, Lesson Four
b. MAVCC, Mid America, Residential Plumbing

LAB HOURS	1
CLASS HOURS	2

EVALUATION (SPT-15)

a. Given a selection of plumbing tools, the student will identify and describe each tool and its function with 100% accuracy.

b. Given a length of tube and a tube bender, the student will bend the tube according to specifications designated by the instructor.

c. Given a length of pipe and specifications, the student will correctly measure and cut it according to the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

i. Closet augers
j. Line clearing tools
k. Seven tapes
l. Internal wrench
m. Basin wrenches
n. End-hex wrenches
o. Measuring pipe

TASK

SPT-16 Identifying and using electrical tools

PERFORMANCE OBJECTIVE

Identify and use electrical tools.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. EMT Bender
    1. NEC standards for bends
    2. Using the bender
b. Correcting knocked over stubs
c. Bending rigid conduit
d. Hydraulic benders
e. Assembling rigid conduit
f. Fish tapes
    1. Basket cable grip
    2. Wire and cable grip
g. Knock-out punches
h. Pliers
i. Wire and cable strippers

(Continued on back)

Provide Demonstration On:

Bending conduit

Provide Practical Application On:

a. Bending a conduit
    1. Flexible
    2. Rigid
b. Using a knock-out punch to punch a hole in box for conduit

INSTRUCTIONAL MATERIALS

Textbooks:

AAVIM, Electrical Wiring

A/Vs:

Hobar, "Housewiring," sound filmstrips

Student Manuals:

Plant Engineering Training Systems, Hand Tools, Lesson Five

Tools and Equipment:

a. EMT bender
b. Selection of electrical tools

LAB HOURS	1
CLASS HOURS	4

EVALUATION (SPT-16)

Given a selection of tools used in electrical work, the student will identify, describe and utilize each tool necessary for bending a conduit. The bend must comply with the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

j. Special screwdrivers
    1. Tightening wire connection screwdriver
    2. Off-set screwdriver
    3. Screw holding screwdriver
k. Voltage tester
l. Fuse pullers

TASK

SPT-17 Identifying and using sheet metal tools

PERFORMANCE OBJECTIVE

Identify and use sheet metal tools.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Types of sheet metal
b. Sheet metal fazes
c. Sheet metal layout
d. Dividers
e. Punches
f. Rivet set
g. Metal cutting chisels
h. Hammer
i. Metal cutting snips
j. Aviation pattern snips
k. Dressing a cut metal sheet
l. Sheet metal notchers
m. Sheet metal punching tools
n. Bench stakes

(Continued on back)

Provide Practical Application On:

Identifying metal working tools in the tool room and describe/demonstrate the use of the tools

INSTRUCTIONAL MATERIALS

Textbooks:

a. Ludwig and McCarthy, Metal Work Technology and Practice
b. Walker, Modern Metalworking

A/Vs:

a. Hobar, "Sheet Metal Hand Tools," transparencies
b. Bergwall, "Sheet Metalwork," filmstrip

Student Manuals:

a. Plant Engineering Training Systems, Hand Tools, Lesson Eight
b. California State Department of Education, Sheet Metal Tools and Equipment Workbook

Tools and Equipment:

Collection of metal working tools

LAB HOURS 1
CLASS HOURS 3

EVALUATION (SPT-17)

Given a selection of metal working tools, the student will identify the tool and demonstrate its proper use. The following tools will be identified:

1. Sheet metal gazes
2. Punches
3. Chisels
4. Rivet sets
5. Hammers
6. Tin snips
7. Forming tools
8. Soldering tools

INSTRUCTIONAL ACTIVITIES

Provide Information On:

o. Sheet metal forming tools
p. Hand seamers
q. Soldering
r. Sheet metal safety

TASK

SPT-18 Identifying and using metal working tools

PERFORMANCE OBJECTIVE

Identify and use metal working tools.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Machine's vise
b. Hacksaws
c. Files
d. File cuts
    1. Single
    2. Double
e. File designations
f. File shape
    1. Tapered
    2. Blunt
g. Selecting a file
h. Tape
i. Tap sets
j. Tap sizes
k. Tap wrenches
l. Uses of taps
m. Tapping lubricants

(Continued on back)

Provide Demonstration On:

a. Using a hacksaw properly
b. The proper use of a file

Provide Practical Application On:

a. Using a hacksaw to cut metal
b. Using a file on metal observing appropriate procedure

INSTRUCTIONAL MATERIALS

Textbooks:

a. Ludwig and McCarthy, *Metal Work and Technology and Practice*
b. Walker, *Modern Metal-working*

Student Manuals:

Plant Engineering Training Systems, *Hand Tools, Lesson Nine*

Tools and Equipment:

a. Hacksaw
b. File
c. Metal material
d. Other examples of metal working tools

LAB HOURS 1

CLASS HOURS 4

EVALUATION (SPT-18)

Given a selection of metal working tools, the student will correctly identify the tools and use the hacksaw and file in the appropriate manner.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

n. Dies
o. Obtaining desired fit
p. Using dies
q. Plates
r. Reamers

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TASK

SPT-19 Identifying and using hoisting and pulling tools

PERFORMANCE OBJECTIVE

Identify and use hoisting and pulling tools.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Block and tackle
    1. Mechanical advantage
    2. Safety
b. Angle of lift
c. Slings
d. Using hitches
    1. Straight
    2. Choker
    3. Basket
    4. Bridle
e. Spreader beams
f. Sling inspection
g. Forged link charms
h. Fabric slings
i. Wire rope slings
j. Chain falls

(Continued on back)

Provide Practical Application On:

Using a block and tackle

INSTRUCTIONAL MATERIALS

Textbooks:

Morrow, Maintenance Engineering Handbook

Student Manuals:

a. Plant Engineering Training Systems, Hand Tools, Lesson Ten
b. Oregon BOE, Unit 301-C

Tools and Equipment:

Block and tackle

LAB HOURS	1
CLASS HOURS	3

EVALUATION (SPT-19)

Given an assortment of hoisting and pulling tools, the student will identify and describe the proper use of each and demonstrate the proper use of a block and tackle.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

k. Ropes
    1. Manila rope
    2. Stretching

l. Wire rope and cable

m. Knots and knot terminology
    1. Standing part, bight, end
    2. Reef knot
    3. Square knot
    4. Figure eight knot
    5. Fisherman's knot
    6. Bowline knot
    7. Timber hitch
    8. Clovi hitch
    9. Cat's paw
    10. Round turn and two half-hitches
    11. Sheep shank
    12. Whipped ends

n. Machine part pullers

o. Vow pullers

p. Push-pullers

q. Slide hammer pullers

r. Choosing the right puller

TASK

BSD-01 Identifying basic principles of blueprint reading

PERFORMANCE OBJECTIVE

Identify basic principles of blueprint reading.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Blueprints
   1. Purpose
   2. Why blueprints are used
b. Title block
   1. Name
   2. Scale
   3. Assembly drawing number
   4. Unit or assembly
   5. Drawing number
   6. Part number
   7. Required parts
   8. Drafting room record
   9. Material
   10. Limits

(Continued on back)

Provide Practical Application On:

Reading basic information on a blueprint and interpreting its meaning

INSTRUCTIONAL MATERIALS

Textbooks:

a. Willis, Blueprint Reading for Commercial Construction
b. Jensen and Hines, Interpreting Engineering Drawings

A/Vs:

Career Aids, Inc., "Drafting and Blueprint Reading Series," tapes/worksheets

Student Manuals:

Plant Engineering Training Systems, Basic Blueprint Reading, Lesson One

Tools and Equipment:

Blueprints

LAB HOURS 2

CLASS HOURS 1

EVALUATION (BSD-01)

Given a blueprint, the student will read and interpret the basic data on the blueprint. The reading must meet standards as set by the instructor.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

c. Lines
d. Notes
e. Reason for more than one view of an object
    1. Auxiliary views
    2. Sections
    3. Pictorial drawings

TASK

BSD-02 Identifying elements of machine drawings

PERFORMANCE OBJECTIVE

Identify elements of machine drawings.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Machine blueprints
b. Introduction to fasteners
c. Screw threads
    1. Helix
    2. External
    3. Internal
    4. Root
    5. Crest
d. How screw threads are shown on drawings
e. Screw thread specifications
    1. Reading thread specifications
    2. ANSI
    3. Bolts

(Continued on back)

Provide Practical Application On:

Identifying and describing machine drawings

INSTRUCTIONAL MATERIALS

Textbooks:

a. Willis, Blueprint Reading for Commercial Construction
b. Jensen and Hines, Interpreting Engineering Drawings

A/Vs:

Career Aids, Inc., "Drafting and Blueprint Reading Series," tapes/worksheets

Student Manuals:

Plant Engineering Training Systems, Basic Blueprint Reading, Lesson Two

Tools and Equipment:

Machine drawings

LAB HOURS	2
CLASS HOURS	1

EVALUATION (BSD-02)

Given a series of machine drawings, the student will identify and interpret the drawings in terms of appropriate terminology and according to the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

    4. Studs
    5. Cap screw
    6. Machine screw
f. Other forms of fastening
    1. Rivets
    2. Welding
g. Transmitting forces within machines
    1. Pin fasteners
    2. Keys
    3. Extension spring
    4. Compression spring
    5. Torsion spring
h. Gear drawings
    1. Gears
    2. Mesh
    3. Spur gears
    4. Bevel gears
    5. Worn gears
    6. Rack and pinion
    7. Involute tooth shape
i. Bearing drawing
    1. Journal or sleeve bearing
    2. Plain bearing
j. Identifying bearing drawings
    1. Ball, roller and needle bearings
    2. Low friction bearings
    3. Races
    4. Thrust load
k. Pulley and belt drawings

TASK

BSD-03 Identifying hydraulic and pneumatic drawings

PERFORMANCE OBJECTIVE

Identify, read and interpret hydraulic and pneumatic drawings.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Fluid systems
b. Pascal's law
c. Multiplication of forces
d. Pistons and cylinders
e. Basic fluid components
    1. Reservoir
    2. Pump
    3. Piping
    4. Control valve
    5. Actuating unit
    6. Hydraulic and pneumatic system drawing symbols

Provide Practical Application On:

Reading hydraulic and pneumatic drawings

INSTRUCTIONAL MATERIALS

Textbooks:

Pease, Basic Fluid Power

Student Manuals:

Plant Engineering Training Systems, Basic Blueprint Reading, Lesson Three

Tools and Equipment:

Hydraulic and pneumatic system schematics

LAB HOURS	4
CLASS HOURS	1

EVALUATION (BSD-03)

Given a series of hydraulic and pneumatic drawings, the student will identify, read and interpret the drawings according to the instructor's specifications.

TASK

BSD-04 Reading building drawings

PERFORMANCE OBJECTIVE

Read and interpret building drawings.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. How blueprints can make a job easier
b. Building and building sites
c. Symbols and conventions on drawings
d. Plat plan
    1. Boundaries, bearings, distances
    2. Degrees and minutes
e. Site plan
f. Building drawings
g. Working drawings
    1. Structural drawings
    2. Elevation drawings
    3. Flow diagram

INSTRUCTIONAL MATERIALS

Textbooks:

a. Willis, Blueprint Reading for Commercial Construction
b. Jensen and Hines, Interpreting Engineering Drawings

A/Vs:

Career Aids, Inc., "Drafting and Blueprint Reading Series," tapes/worksheets

Student Manuals:

Plant Engineering Training Systems, Basic Blueprint Reading, Lesson Five

Tools and Equipment:

Building drawings

LAB HOURS	4
CLASS HOURS	1

EVALUATION (BSD-04)

Given a building drawing, the student will read and interpret the drawing according to the instructor's specifications.

TASK

BSD-05 Reading electrical drawings

PERFORMANCE OBJECTIVE

Read and interpret electrical drawings.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Wiring diagram applications
b. Using power distribution diagrams
    1. Loads
    2. Circuit breakers or fuses
c. Power distribution circuits
    1. Primary transformer winding
    2. Secondary transformer winding
    3. Neutral or identified conductor
    4. Hot conductor

(Continued on back)

Provide Practical Application On:

Reading and interpreting electrical blueprints

INSTRUCTIONAL MATERIALS

Textbooks:

a. Willis, Blueprint Reading for Commercial Construction
b. Jensen and Hines, Interpreting Engineering Drawings

A/Vs:

Career Aids, Inc., "Drafting and Blueprint Reading Series," tapes/worksheets

Student Manuals:

Plant Engineering Training Systems, Basic Blueprint Reading, Lesson Six

Tools and Equipment:

Electrical blueprints

LAB HOURS 4
CLASS HOURS 1

EVALUATION (BSD-05)

Given an electrical blueprint, the student will read and interpret the drawing according to the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

d. Electrical drawings
    1. Plot plants
    2. Riser drawings
    3. Single line wiring diagram
    4. Title blocks
e. Electrical blueprint application
f. Plant wiring requirements
    1. Conduit
    2. Flexible arm and wiring of BX cable
    3. Explosion proof wiring
g. Safety

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TASK

BSD-06 Reading pipe system drawings

PERFORMANCE OBJECTIVE

Read and interpret pipe system drawings.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Application of piping diagrams
   1. Single line piping diagram
   2. Riser diagrams
b. Purpose of piping systems
   1. Distribution
   2. Waste
c. Piping materials
   1. Copper
   2. Iron and steel
d. Pipe fittings
   1. Street elbow
   2. Coupling
   3. Plug

(Continued on back)

Provide Practical Application On:

Reading and interpreting pipe system drawings

INSTRUCTIONAL MATERIALS

Textbooks:

Pease, Basic Fluid Power

Student Manuals:

Plant Engineering Training Systems, Basic Blueprint Reading, Lesson Seven

Tools and Equipment:

Pipe system diagrams

LAB HOURS 3

CLASS HOURS 1

EVALUATION (BSD-06)

Given a pipe system drawing, the student will read and interpret the drawing according to the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

- e. Use of valves
  - 1. Dreck valves
  - 2. Direction of flow
- f. Pipe system drawings
  - 1. Scale layouts and single-line layouts
  - 2. Orthographic projections
  - 3. Elevation and plan
  - 4. Developed diagrammatic layouts
- g. Pictorial piping diagrams
- h. Architectural piping diagrams

TASK

BSD-07 Reading sheet metal drawings

PERFORMANCE OBJECTIVE

Read and interpret sheet metal drawings.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

- a. Uses of sheet metal
  - 1. Galvanized
  - 2. Aluminum
- b. Duct system drawings
- c. Ventilation system components and symbols
  - 1. Ducts
  - 2. Duct sections
  - 3. Direction of flow
  - 4. Supply outlets
  - 5. Return or exhaust grills
  - 6. Access doors
  - 7. Dampers
  - 8. Dual duct system
  - 9. Through ceiling type diffusers
  - 10. Sill aerators

(Continued on back)

Provide Practical Application On:

Reading and interpreting sheet metal drawings

INSTRUCTIONAL MATERIALS

Textbooks:

- a. Feirer, *General Metals*
- b. Walker, *Modern Metalworking*

A/Vs:

Career Aids, Inc., "Sheet Metal Work Explained," filmstrips/tapes

Student Manuals:

Plant Engineering Training Systems, *Basic Blueprint Reading, Lesson Eight*

Tools and Equipment:

Sheet metal drawings

LAB HOURS 4

CLASS HOURS 1

EVALUATION (BSD-07)

Given a sheet metal drawing, the student will read and interpret the drawing according to the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

d. Forming sheet metal parts
    1. Developments
    2. Parallel developments
    3. Truncated cylinders
    4. Radial developments
    5. Truncated pyramids
    6. Triangulated developments

e. Sheet metal connection drawings

TASK

BSD-08 Using shop math to interpret blueprints

PERFORMANCE OBJECTIVE

Use shop math to interpret blueprints.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Calculating dimensions on blueprints
   1. Straight line measurement
   2. Fractions
   3. Decimals
b. Addition
c. Subtraction
d. Multiplication
e. Divisions
f. Adding and subtracting decimals
g. Multiplying decimals
h. Adding and subtracting fractions
   1. Numerator
   2. Denominator
   3. Common denominator

(Continued on back)

Provide Practical Application On:

Calculating dimensions on blueprints

INSTRUCTIONAL MATERIALS

Textbooks:

a. Delmar, Mathematics for the Shop
b. Hobar, Practical Problems in Math Series

Student Manuals:

Plant Engineering Training Systems, Basic Blueprint Reading, Lesson Nine

Tools and Equipment:

Blueprints

LAB HOURS 4

CLASS HOURS 1

EVALUATION (BSD-08)

Given a blueprint with dimensions which are not labeled, the student will calculate the dimensions according to the instructor's specifications. The student will also read and interpret the blueprint.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

    4. Mixed numbers
    5. Proper and improper fractions
i. Multiplying fractions
j. Dividing fractions
k. Angles
    1. Degrees, minutes and seconds
    2. Adjacent angles
    3. Opposite angles
l. Areas of rectangles
m. Radius

TASK

BSD-09 Sketching schematic diagrams

PERFORMANCE OBJECTIVE

Sketch a schematic diagram.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Visualizing the drawing
b. Applying sketching techniques
    1. Dimensions
    2. Written descriptions
c. Orthographic sketching
d. Pictorial sketching
e. Isometric sketching
f. Oblique sketching
    1. Cabinet sketching
    2. Cavalier sketching
g. Perspective sketching
h. Shading
    1. Continuous tone
    2. Line tone
i. Sketching a schematic diagram

Provide Practical Application On:

Drawing/sketching a schematic diagram from specifications

INSTRUCTIONAL MATERIALS

Textbooks:

a. Willis, Blueprint Reading for Commercial Construction
b. Jensen and Hines, Interpreting Engineering Drawings

A/Vs:

Career Aids, Inc., "Drafting and Blueprint Reading Series," tapes/worksheets

Student Manuals:

Plant Engineering Training Systems, Basic Blueprint Reading, Lesson Ten

Tools and Equipment:

a. Pencils
b. Drawing media

LAB HOURS	4
CLASS HOURS	1

EVALUATION (BSD-09)

Given specifications and necessary supplies, the student will sketch a schematic diagram according to the instructor's specifications.

TASK

BSD-10 Identifying types of schematics used in plant engineering

PERFORMANCE OBJECTIVE

Identify types of schematics used in plant engineering.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Purpose of symbols
b. Schematics
c. Why plant maintenance engineers must be able to read schematics
d. Why schematics are used
e. Electrical diagrams
f. Piping diagrams
g. Fluid power diagrams
h. Using schematics in plant maintenance
i. Cutaway diagram
j. Pictorial diagram
k. Combination diagram

Provide Practical Application On:

a. Interpreting a schematic
b. Interpreting a piping diagram

INSTRUCTIONAL MATERIALS

Textbooks:

a. Morrow, Plant Engineering Handbook
b. Smith, Electricity for Refrigeration, Heating and Air Conditioning

A/Vs:

Career Aids, Inc., "Basic Electricity and Electronics Explained," filmstrips/tapes

Student Manuals:

Plant Engineering Training Systems, Reading Schematics and Symbols, Lesson One

Tools and Equipment:

a. Schematic diagrams
b. Piping diagrams

LAB HOURS 4
CLASS HOURS 1

EVALUATION (BSD-10)

Given a schematic diagram and a piping diagram, the student will correctly identify basic symbols and read the diagram according to the instructor's specifications.

TASK

BSD-11 Identifying the symbols on electrical, piping and fluid power diagrams

PERFORMANCE OBJECTIVE

Identify the symbols used in electrical piping and fluid power diagrams.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. The meaning of lines
   1. Electrical
   2. Piping
   3. Fluid power
b. Legend
c. Kinds of lines
d. Symbols as opposed to pictures
e. Linking the symbols to form a system
f. Determining the type of system from a diagram
g. How the elements connect in a system

Provide Practical Application On:

Determining the type of system from a diagram

INSTRUCTIONAL MATERIALS

Textbooks:

a. Morrow, Plant Engineering Handbook
b. Bobbs-Merrill, Industrial Electronic Systems
c. Howard W. Sams & Co., Inc., Collected Basic Circuits

A/Vs:

Career Aids, Inc., "Basic Electricity and Electronics Explained," filmstrips/tapes

Student Manuals:

Plant Engineering Training Systems, Reading Schematics and Symbols, Lesson Two

Tools and Equipment:

Electrical, piping and fluid power diagrams

LAB HOURS	3
CLASS HOURS	1

EVALUATION (BSD-11)

Given an electrical, piping or fluid power diagram, the student will correctly identify the type of system diagrammed and identify the purpose of each symbol used. All diagram identifications should be within the instructor's specifications.

TASK

BSD-12 Identifying guidelines for reading schematics

PERFORMANCE OBJECTIVE

Identify guidelines for reading schematics.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

- a. Looking for the flows in the system
  - 1. Piping flows
  - 2. Electrical flows
- b. Looking for clues
  - 1. Check valves
  - 2. Gage symbols
  - 3. Combination symbols
- c. Reading diagrams
- d. Troubleshooting guidelines
  - 1. Getting a grasp on the whole system
  - 2. Identifying the problem

Provide Practical Application On:

Looking at diagrams and determining direction of flow

INSTRUCTIONAL MATERIALS

Textbooks:

- a. Smith, Electricity for Refrigeration, Heating, and Air Conditioning
- b. Morrow, Maintenance Engineering Handbook

Student Manuals:

Plant Engineering Training Systems, Reading Schematics and Symbols, Lesson Three

Tools and Equipment:

Electrical, piping and fluid power diagrams

LAB HOURS 2

CLASS HOURS 1

EVALUATION (BSD-12)

Given an electrical, piping or fluid power diagram, the student will interpret the diagram and correctly identify the direction of the flow according to the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

3. Determining possible causes for the problem
4. Studying a local area of the schematic

TASK

BSD-13 Identifying electrical symbols

PERFORMANCE OBJECTIVE

Identify electrical symbols.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Importance of following troubleshooting procedure
b. Wires
    1. Connections
    2. Crossings
c. Switches
    1. Disconnect
    2. Push button
d. Power sources
    1. Positive terminal
    2. Negative terminal
e. Electrical loads
f. Coils, inductors and transformers
g. Fuses, circuit breakers and grounds

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Provide Practical Application On:

Identifying electrical symbols on a schematic

INSTRUCTIONAL MATERIALS

Textbooks:

a. Loper and Ahr, Electricity and Electronics
b. Delmar, Electronics, Electricity, Electro-Mechanical Technology
c. Howard W. Sams & Co., Inc., How to Read a Schematic Diagram

Student Manuals:

Plant Engineering Training Systems, Reading Schematics and Symbols, Lesson Four

Tools and Equipment:

Electrical schematics

LAB HOURS	2
CLASS HOURS	1

EVALUATION (BSD-13)

Given a schematic diagram, the student will identify electrical symbols and describe their purpose in the schematic. The completed task should be in accordance with the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

h. Contacts and resistors
    1. Contact N.O.; N.C.
    2.. Fixed resistors
    3. Adjustable resistors, rheostats, potentiometers
i. Connecting symbols

TASK

BSD-14 Reading electrical diagrams

PERFORMANCE OBJECTIVE

Read an electrical diagram.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Electrical schematic diagrams
b. Wiring diagrams
c. Wires shown as lines or color coded
d. Wiring diagram and schematic compared
e. Components
    1. Power source
    2. Load
    3. Wires
f. Switches
g. Series and parallel circuits
h. A systems approach to reading electrical diagrams
i. Making an industrial schematic

Provide Practical Application On:

Reading an electrical diagram to trace a component of a system

INSTRUCTIONAL MATERIALS

Textbooks:

Howard W. Sams & Co., Inc., How to Read Schematic Diagrams

Student Manuals:

Plant Engineering Training Systems, Reading Schematics and Symbols, Lesson Five

Tools and Equipment:

Electrical diagram and system

LAB HOURS 2
CLASS HOURS 1

EVALUATION (BSD-14)

Given an electrical diagram, the student will trace the wiring of the circuit to a specified component. The completed task must meet the instructor's specifications.

TASK

BSD-15 Identifying piping symbols

PERFORMANCE OBJECTIVE

Identify piping symbols.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Pipes transfer fluids and gases
b. Piping diagrams
    1. Controlled flow valves
    2. Importance of piping systems
    3. Methods of drawing piping diagrams
c. Differing views
    1. Orthographic projection
    2. Isometric
d. Types of joints
    1. Screwed
    2. Welded
    3. Flanged
    4. Bell-and-spigot
    5. Soldered

(Continued on back)

Provide Practical Application On:

Identifying symbols on a piping diagram

INSTRUCTIONAL MATERIALS

Textbooks:

a. Morrow, *Maintenance Engineering Handbook*
b. Willis, *Blueprint Reading for Commercial Construction*

A/Vs:

Career Aids, Inc., "Drafting and Blueprint Reading," tapes/worksheets

Student Manuals:

Plant Engineering Training Systems, *Reading Schematics and Symbols, Lesson Six*

Tools and Equipment:

Piping diagrams

LAB HOURS 2

CLASS HOURS 1

EVALUATION (BSD-15)

Given a piping diagram, the student will correctly identify the symbols according to the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

e. Fittings
    1. Changing direction of flow
    2. Changing the size of the pipe
    3. Providing branch connections
    4. Closing a pipe line

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TASK

BSD-16 Reading piping schematics

PERFORMANCE OBJECTIVE

Read a piping schematic.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Piping systems
    1. Joints
    2. Fittings
    3. Valves
    4. Gate valve
    5. Plug valve
    6. Globe valve
    7. Check valve
b. Reading a single schematic

Provide Practical Application On:

Reading a simple piping schematic

INSTRUCTIONAL MATERIALS

Textbooks:

Willis, Blueprint Reading for Commercial Construction

Student Manuals:

a. Plant Engineering Training Systems, Reading Schematics and Symbols, Lesson Seven
b. Oregon, Symbols
c. Oregon, Basic Symbols

Tools and Equipment:

Piping schematics

LAB HOURS	2
CLASS HOURS	1

EVALUATION (BSD-16)

Given a simple schematic of a piping system, the student will read and interpret the schematic according to the instructor's specifications.

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TASK

BSD-17 Identifying fluid power symbols

PERFORMANCE OBJECTIVE

Identify fluid power symbols.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Elements of a system
   1. Pump
   2. Fluid
   3. Piping
b. Pneumatics
c. Hydraulics
d. Reservoir or receiver
e. Pump or compressor
   1. Fixed displacement pump
   2. Variable displacement pump

(Continued on back)

Provide Practical Application On:

Identifying symbols on a fluid power schematic

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

A/Vs:

Howard W. Sams & Co., Inc., "Fluid Power," transparencies

Student Manuals:

Plant Engineering Training Systems, Reading Schematics and Symbols, Lesson Eight

Tools and Equipment:

Fluid power schematics

LAB HOURS	3
CLASS HOURS	1

EVALUATION (BSD-17)

Given a fluid power schematic, the student will correctly identify symbols on the schematic.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

f. Actuator
  1. Linear actuator
  2. Single or double acting cylinders
  3. Differential cylinders
  4. Rotary actuator
  5. Fixed or variable displacement

g. Valves
  1. Power or directional
  2. Mechanical or electrical

h. Describing valves by
  1. The number of ways fluids enter or leave the valve
  2. The number of positions the valve can operate

i. Tubing or piping

TASK

BSD-18 Reading fluid power schematics

PERFORMANCE OBJECTIVE

Read fluid power schematics.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Composite symbols
b. Tracing fluid power circuits
c. Hydraulic circuits
d. Pneumatic circuits
e. Types of fluid power diagrams
    1. Pictorial
    2. Cutaway
    3. Schematic

Provide Practical Application On:

Reading a simple fluid power schematic

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

Student Manuals:

Plant Engineering Training Systems, Reading Schematics and Symbols, Lesson Nine

Tools and Equipment:

Fluid power schematics

LAB HOURS	3
CLASS HOURS	1

EVALUATION (BSD-18)

Given a fluid power schematic, the student will correctly read and interpret symbols and direction of flow on the schematic.

TASK

BSD-19 Identifying welding symbols

PERFORMANCE OBJECTIVE

Identify welding symbols.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Welding processes
    1. Pressure welding
    2. Non-pressure welding
b. Three methods of fusion welding
    1. Arc welding
    2. Gas welding
    3. Resistance welding
c. Assembled welding symbol
    1. Reference line
    2. Arrow
    3. Basic weld symbol
    4. Dimensions and other data
    5. Supplementary symbols
    6. Finish symbol

(Continued on back)

Provide Practical Application On:

Identifying and interpreting welding symbols

INSTRUCTIONAL MATERIALS

Textbooks:

Griffin and Roden, Welding Processes

A/Vs:

Hobar, "Blueprint Reading for Welders," transparencies

Student Manuals:

Plant Engineering Training Systems, Reading Schematics and Symbols, Lesson Ten

Tools and Equipment:

Welding diagram

LAB HOURS 2

CLASS HOURS 1

EVALUATION (BSD-19)

Given a welding symbol, the student will identify and interpret the symbol according to the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

    7. The tail
    8. Specifications, processes and other references
d. Location of the weld
e. Symbols
    1. Weld-all-around
    2. Spot, seam, flash
    3. Break in arrow of bevel and J-groove
    4. Combination symbols
f. Special weld designations
    1. Cross section view on detail drawing
    2. Field weld symbol

TASK

BSD-20 Drawing electrical one-line diagrams from engineering sketches

PERFORMANCE OBJECTIVE

Draw electrical one-line diagrams from engineering sketches.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Definition and purpose
b. System selection
    1. Radial system
    2. Primary selective system
    3. Secondary selective system
    4. Primary selective, secondary network system
c. Information sources
d. Power transformer
e. Circuit breakers
f. Fuses
g. Connected loads
h. Metering devices
i. Miscellaneous devices
j. One-line diagram examples
k. Symbol standards
l. Checklist

Provide Demonstration On:

Techniques for layout and drawing one-line diagrams

Provide Practical Application On:

Drawing a one-line diagram from an engineering sketch

INSTRUCTIONAL MATERIALS

Textbooks:

Snow, Electrical Drafting and Design

Tools and Equipment:

Drafting kit

LAB HOURS	12
CLASS HOURS	1

EVALUATION (BSD-20)

Given an engineering sketch of a one-line diagram, necessary symbol references and drafting supplies and equipment, the student will draw a one-line diagram. The student must score a "B" or better on all items using the "Design Drafting Grading Sheet".

TASK

BSD-21 Drawing electrical elementary diagrams from engineering sketches

PERFORMANCE OBJECTIVE

Draw electrical elementary diagrams from engineering sketches.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Definition and purpose
b. Symbols
c. Relays
d. Solenoids
e. Mechanically operated swithces
f. Selector switches
g. Overload relays for motor starters
h. Control power source
i. Steps in developing an elementary diagram
j. Motor starting with start-stop push
k. Motor starting with start-stop push button stations
l. Two wire control circuits

(Continued on back)

Provide Demonstration On:

Techniques for laying out and drawing elementary diagrams

Provide Practical Application On:

Drawing an electrical diagram from an existing engineering sketch

INSTRUCTIONAL MATERIALS

Textbooks:

Snow, Electrical Drafting and Design

Tools and Equipment:

Drafting kit

LAB HOURS 12
CLASS HOURS 1

EVALUATION (BSD-21)

Given an engineering sketch of an electrical elementary diagram, necessary symbol references and drafting supplies and equipment, the student will draw an electrical elementary diagram. The student must score a "B" or better on all items using the "Design Drafting Grading Sheet".

INSTRUCTIONAL ACTIVITIES

Provide Information On:

m. Sequence control
n. Wire numbers on elementary diagrams
o. Wire requirements
p. Layout and drawing techniques

TASK

BSD-22 Drawing electronic schematic diagrams from engineering sketches

PERFORMANCE OBJECTIVE

Draw electronic diagrams from engineering sketches.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Definition and purpose
b. Composition of diagrams
    1. Symbols and arrangement
    2. Signal and power flow
    3. Component identification
    4. Operating controls
c. Stage layouts
d. Switch circuitry
e. Logic diagrams
f. Filter and tuned circuits
g. Geometric systems layout
h. Simplified layouts
i. Relay circuits
j. Estimating space requirements

(Continued on back)

Provide Demonstration On:

Techniques for laying out and drawing schematic diagrams

Provide Practical Application On:

Drawing an electrical diagram from an existing engineering sketch

INSTRUCTIONAL MATERIALS

Textbooks:

a. Raskhodoff, Electrical Drafting and Design
b. Stiers, Electric Drafting

Tools and Equipment:

a. Drafting kit
b. Electronics schematic template

LAB HOURS	12
CLASS HOURS	1

EVALUATION (BSD-22)

a. Given an engineering sketch of an electronic schematic diagram, necessary symbol references and drafting supplies and equipment, the student will draw an electronic schematic diagram. The student must score a "B" or better on all items using the "Design Drafting Grading Sheet".

b. V'TECS, Electronics Mechanics, Task No. C-25.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

k. Schematic diagram practices and layout procedures
l. Integrated circuits
m. Reference information

TASK

BSD-23 Preparing preliminary sketches

PERFORMANCE OBJECTIVE

Prepare a rough preliminary sketch of an electronic circuit when given a set of circuit parameters.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Basic logic systems
b. Basic analog systems
c. Standard schematic layout
d. Standard symbols

Provide Demonstration On:

a. Layout a rough sketch of a circuit.
b. Redraw the sketch to conform to standard drafting techniques.

Provide Practical Application On:

Rough sketches of an electronic circuit using written circuit specifications

INSTRUCTIONAL MATERIALS

Textbooks:

Newnes, Electronic Diagrams; Simple Circuit Building; Electronic Components; Printed Circuit Assembly; Practical Electronic Project Building; Project Planning and Building

Tools and Equipment:

a. Circuit specifications
b. Paper, pencil

LAB HOURS	12
CLASS HOURS	1

EVALUATION (BSD-23)

a. Given written requirements for a circuit function, the student will select a basic circuit design and prepare a preliminary sketch of the circuit proposing component values and power supply requirements. The design must be functional.

b. V'TECS, Electronics Mechanics, Task No. C-8 and C-17.

TASK

BSD-24 Drawing logic symbols

PERFORMANCE OBJECTIVE

Draw the logic symbols for: AND, OR, NOR, NAND, ECLUSIVE OR and FLIP-FLOPS.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Standard electronic logic symbols
b. Standard industiral logic symbols "NEMA"
c. Standard military logic symbols

Provide Demonstration On:

a. Drawing the Different logic symbols using the basic electronic standards
b. Drawing the different logic symbols using the industrial logic symbols standard

Provide Practical Application On:

a. Drawing electronic logic symbols
b. Drawing industiral logic symbols

INSTRUCTIONAL MATERIALS

Textbooks:

Buck, Lab Volt Systems; Digital Trainer Manuals

Student Manuals:

Georgia, Electronics Technology, Microcomputer Concepts, Units MC-1, MC-2 and MC-3

Tools and Equipment:

a. Locgic names
b. Digital manuals

LAB HOURS	12
CLASS HOURS	1

EVALUATION (BSD-24)

a. Given a list of gates, the learner will draw from memory the electronic and industrial symbol of each. One hundred percent accuracy is required.

b. Georgia, Microcomputer Concepts, Student Tests.

TASK

POM-01 Identifying the physical structure of metals

PERFORMANCE OBJECTIVE

Identify the physical structure of metals.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Definition of a metal
    1. Lustrous appearance
    2. Conductivity
    3. Number of metals in existence
b. Metallurgy
    1. Ores
    2. Chemical metallurgy
    3. Physical metallurgy
c. Properties of metals
    1. Strength
    2. Malleability
    3. Ductility
    4. Toughness
    5. Elasticity
    6. Ferromagnetic
    7. Thermocouple
d. Melting point of metals
    1. Definition
    2. Latent heat of fusion
e. Arrangement of atoms in metals
    1. Space lattice or geometric crystal structure
    2. Hexagonal close packed space lattice
f. Crystal formation
g. Composition of alloys
h. Nonferrous alloys
i. Cadmium
j. Cobalt
k. How metals are cast
l. Metal working
m. How metals are joined

INSTRUCTIONAL MATERIALS

Textbooks:

a. Feirer, General Metals
b. Harold V. Johnson, Technical Metals

Student Manuals:

Plant Engineering Training Systems, Metal Materials, Lesson One

LAB HOURS	4
CLASS HOURS	1

EVALUATION (POM-01)

Given a metal, the student will correctly identify its physical structure in terms of appearance, conductivity, malleability and melting point.

TASK

POM-02 Identifying properties of metals

PERFORMANCE OBJECTIVE

Identify properties of metals.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Mechanical properties
    1. Hardness
    2. Ductility
    3. Machinability
    4. Tensile strength
b. Stress
c. Kinds of stress
    1. Tension
    2. Compression
    3. Shear
d. Elasticity
    1. Elastic limit
    2. Ultimate breaking strength
e. Strain
f. Metal fatigue

(Continued on back)

Provide Demonstration On:

Figuring tensile strength

Provide Practical Application On:

Figuring tensile strength

INSTRUCTIONAL MATERIALS

Textbooks:

a. Feirer, General Metals
b. Harold V. Johnson, Technical Metals

Student Manuals:

Plant Engineering Training Systems, Metal Materials, Lesson Two

LAB HOURS	4
CLASS HOURS	1

EVALUATION (POM-02)

Given a metal, the student will correctly identify its basic properties and figure tensile strength for a specified area and force.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

g. Causes of failure
    1. Elastic breakdown
    2. Creep failures
h. Usable strength of metal
i. Heat and temperature
    1. Friction
    2. Motion of molecules
    3. Transfer of heat
    4. Heat and cold
j. Expansion of metals
k. Density
l. Specific gravity

TASK

POM-03 Identifying non-metal materials

PERFORMANCE OBJECTIVE

Identify non-metal materials.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

- a. Classification of materials
    - 1. Solid
    - 2. Liquid
    - 3. Gas
    - 4. Kinetic energy
- b. Properties of gases
    - 1. Standard temperature and pressure
    - 2. Intensity
- c. Behavior of gases
    - 1. $P_1V_1 = P_2V_2$ (Boyle's law)
    - 2. Changing a gas to a liquid
- d. Properties of liquids
    - 1. Meniscus
    - 2. Viscosity
    - 3. Density
    - 4. Specific gravity
    - 5. Freezing point
    - 6. Vapor pressure
    - 7. Evaporation
    - 8. Condensation
    - 9. Boiling point
    - 10. Volatility
    - 11. Buoancy
- e. Behavior of liquids at rest
- f. Fluids in motion
    - 1. Streamline or laminar flow
    - 2. Turbulent flow
    - 3. Cavitiation
- g. Solids
    - 1. Crystalline structures
    - 2. Melting point
    - 3. Amorphous materials
- h. Mixed phases

INSTRUCTIONAL MATERIALS

Textbooks:

Olivio and Olivio, Fundamentals of Applied Physics

Student Manuals:

Plant Engineering Training Systems, Non-metal Materials, Lesson One

LAB HOURS	4
CLASS HOURS	1

EVALUATION (POM-03)

Given specifications for a non-metal substance, the student will identify the substance in terms of its state of matter and describe its properties according to the instructor's specifications.

TASK

POM-04 Identifying properties and applications of carbon

PERFORMANCE OBJECTIVE

Identify properties and applications of carbon.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

- a. Carbon and graphite
  - 1. Forms of carbon
  - 2. Applications of carbon
  - 3. Forms of graphite
  - 4. Applications of graphite
  - 5. Production of graphite
  - 6. Charcoal
  - 7. Lamp black
- b. Properties and characteristics of carbon and graphite
  - 1. Heat resistance
  - 2. Thermal shock resistance
  - 3. Heat and electrical conductivity
  - 4. Does not melt
  - 5. Inert to chemical action
  - 6. Lubricates under special conditions
- c. Carbon in batteries and resistors
  - 1. Carbon rods in batteries
  - 2. Carbon piles for current control
  - 3. Construction of a resistor
- d. Carbon electrodes for lighting and welding
- e. Refractory (furnace applications of carbon

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

Smith, Materials of Construction

Student Manuals:

Plant Engineering Training Systems, Non-metal Materials, Lesson Four

LAB HOURS 4

CLASS HOURS 1

EVALUATION (POM-04)

Given specifications for a carbon or graphite material, the student will correctly identify their applications and describe the process used to produce them.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

f. Carbon brushes
g. Carbon brush problems
    1. Noisy operation
    2. Burned spots
    3. Excessive surface film build-up
    4. Oil on the commutator
h. Carbon brush grades
i. Industrial diamonds
j. Fabricating carbon and graphite products
    1. Powder base
    2. Binder material such as pitch, tar, resins
    3. Heat
k. Mechanical parts and seals
l. Carbon bearings
m. Pump and valve parts
n. Chemical application

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TASK

POM-05 Identifying properties of rubber

PERFORMANCE OBJECTIVE

Identify properties of rubber.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Nature of rubber
    1. Latex
    2. Elasticity
    3. Resilience
    4. Elastomers
    5. Permanent set
    6. Impermeable
b. Rubber processing
c. Kinds of rubber
    1. Natural rubber
    2. SBR
    3. Butyl rubber
    4. Neoprene
    5. Polysulfide rubber
    6. Nitrile rubber
    7. Silicone rubber
    8. Fluorocarbon rubber
d. Groups of rubber
    1. Class R
    2. Class S
    3. Class T
e. Properties of rubber
    1. Electrical resistance
    2. Flame resistance
    3. Impermeability
    4. Resistance to heat or cold
    5. Oxidation
f. Rubber applications
g. Vulcanizing rubber
h. Foamed rubber
    1. Inert gas under pressure

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

Smith, Materials of Construction

Student Manuals:

Plant Engineering Training Systems, Non-metal Materials, Lesson Three

LAB HOURS	4
CLASS HOURS	1

EVALUATION (POM-05)

Given specifications for a rubber application, the student will correctly identify the type of rubber, its properties and the process used to produce it.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

    2. Blowing agent
    3. Whipped latex
i. Hoses and tubing
    1. Lining
    2. Reinforcement
    3. Cover
j. Tank linings
k. Conveyor and drive belts
l. Sheet rubber
m. Wire and cable insulation
n. Reclaiming rubber

TASK

POM-06 Identifying properties of industrial chemicals

PERFORMANCE OBJECTIVE

Identify industrial chemicals and their applications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Characteristics of chemicals
   1. Acid
   2. Neutral
   3. Alkaline
   4. pH scale
   5. Safety

b. Soaps and detergents
   1. Tallow
   2. Detergents - surfactants
   3. Biodegradable detergents

c. Alkali cleansers

d. Solvents
   1. Chlorinated solvents
   2. Thinners

e. Acids
   1. Safety
   2. Muriatic
   3. Nitric
   4. Phosphoric
   5. Sulfamic

f. Industrial gases
   1. Nitrogen
   2. Oxygen
   3. Chlorine
   4. Carbon dioxide
   5. Ammonia
   6. Hydrogen
   7. Acetylene

g. Packaged chemicals
   1. Types
   2. Applications

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

Smith, Materials of Construction

Student Manauls:

Plant Engineering Training Systems, Non-metal Materials, Lesson Five

LAB HOURS	4
CLASS HOURS	1

EVALUATION (POM-06)

Given a specified industrial chemical, the student will identify the chemical and describe its applications according to the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

h. Aerosols
i. Lubricants and oils
    1. Graphite
    2. Molybdenum
j. Refrigerants and water treatments
    1. Ammonia
    2. Chlorinated and hydrocarbons florinated
    3. Safety
k. Welding and plating aids
l. Fuels
m. Fire fighting chemicals
    1. Class A
    2. Class B
    3. Class C
    4. Class D
n. Protective equipment
    1. Clothing
    2. Safety instruments

TASK

POM-07 Identifying the properties of paints, coatings and their applications

PERFORMANCE OBJECTIVE

Identify paints, coatings and their applications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Applications
    1. Wood protection
    2. Steel protection
b. Substrates
    1. Fabric
    2. Wood
    3. Metal surfaces
c. Pigments and vehicles
    1. Paint
    2. Thinner
    3. Water emulsion paints
    4. Acrylic and polyvinyl paints
d. Common interior paints
    1. Ester grim
    2. Alkyl
    3. Phenolic

(Continued on back)

Provide Demonstration On:

a. Selecting a primer
b. Selecting a surface coating
c. Selecting a method of application

Provide Practical Application On:

Selecting a primer, surface coating and method of application to paint a given surface

INSTRUCTIONAL MATERIALS

Textbooks:

Smith, *Materials of Construction*

Student Manuals:

Plant Engineering Training Systems, *Non-metal Materials*, *Lesson Six*

Tools and Equipment:

a. Paints
b. Primers
c. Brushes
d. Rollers
e. Sprayers
f. Wire brush
g. Sander
h. Thinner
i. Paint stirring rod or paddle

LAB HOURS 4

CLASS HOURS 1

EVALUATION (POM-07)

Given a material to paint, the student will select a primer, a surface coating and a method of application. The student will identify and observe all safety precautions. Tasks must comply with the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

    4. Epoxy
    5. Silicone
    6. Latex
    7. Synthetic rubber
- e. Solvent safety
    1. Ventilation
    2. Skin contact
    3. Flame
    4. Personal injury and damage to equipment
- f. Primer selection
    1. Substrate material
    2. Surface condition
    3. Type of finish to be applied
    4. Cathodic protection
- g. Surface coating selection
    1. Substrate
    2. Surface conditions
    3. Selecting coating
    4. Method of application
    5. Preparing surface
- h. Surface preparation
    1. Wood
    2. Metal
    3. Masonry
- i. Methods of application
    1. Brush
    2. Roller
    3. Spraying
    4. Dip
- j. Zinc coating
- k. Utilizing colors
- l. Speciality coatings
- m. Paint terminology

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TASK

POM-08 Identifying the properties of insulating materials and their applications

PERFORMANCE OBJECTIVE

Identify properties of insulating materials and their applications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. How insulation works
b. Heat transfer
    1. Conduction
    2. Convection
    3. Radiation
c. Thermal insulating materials
d. Roll and batt insulation
e. Loose fill insulation
f. Low density insulation applications
g. Special insulation for extreme temperatures
h. Accoustical insulation
i. Sound absorbing materials
j. Vapor barriers
    1. Flame resistant jacket
    2. Low pressure or universal jacket
    3. Coatings
k. Electrical insulation
l. Fire barriers

INSTRUCTIONAL MATERIALS

Textbooks:

Smith, Materials of Construction

Student Manuals:

Plant Engineering Training Systems, Non-Metal Materials Lesson Seven

LAB HOURS 4
CLASS HOURS 1

EVALUATION POM-08

Given an application which requires insulation, the student will accurately identify an insulator and describe its application.

TASK

POM-09 Identifying properties and applications of construction materials

PERFORMANCE OBJECTIVE

Identify properties and applications of construction materials.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Inspection of construction materials
b. Concrete
    1. Applications
    2. Hydration
    3. Types of cement
    4. Aggregates
c. Mixing
d. Defects
    1. Spalling
    2. Crazing
    3. Dusting
e. Stain removal
f. Patching and repairs
g. Masonry products
    1. Concrete masonry
    2. Concrete block
h. Bricks
    1. Face brick
    2. Building a common brick
    3. ASTM grades
i. Mortar
    1. ASTM classifications
    2. Repointing
j. Wallboard
    1. Gypsum wall or drywall
    2. Gypsum backing board
k. Wallboard repairs
l. Plaster
    1. Plaster of paris
    2. Hard-wall plaster
    3. Hard-finish plaster
    4. Special plaster
m. Glass
    1. Glass block
    2. Plastic glazing

INSTRUCTIONAL MATERIALS

Textbooks:

a. Dezettel, Masons and Builders Library
b. Smith, Materials of Construction

A/Vs:

DCA Educational Products, "Brick and Stone Masonry," transparencies

Student Manuals:

Plant Engineering Training Systems, Non-metal Materials, Lesson Eight

LAB HOURS	4
CLASS HOURS	1

EVALUATION (POM-09)

Given specifications for an industrial construction application, the student will accurately identify all the materials to be used and describe their properties.

TASK

POM-10 Identifying properties and applications of wood

PERFORMANCE OBJECTIVE

Identify properties and applications of wood.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Lumber industry
   1. Headrig
   2. Edger
   3. Kilns
b. Wood properties
   1. Hardwoods
   2. Softwoods
   3. Lignin
c. Wood grades
   1. Select
   2. Common
d. Hardwood grades
   1. Firsts
   2. Seconds
   3. Sweet
   4. Common

(Continued on back)

Provide Demonstration On:

Selecting appropriate type and quantity of wood

Provide Practical Application On:

Selecting the appropriate wood and the proper number of board feet

INSTRUCTIONAL MATERIALS

Textbooks:

Smith, Materials of Construction

A/Vs:

Hobar, "Wood Technology," transparencies

Student Manuals:

Plant Engineering Training Systems, Non-metal Materials, Lesson Nine

LAB HOURS	4
CLASS HOURS	1

EVALUATION (POM-10)

Given specifications for a job, the student will accurately select the appropriate type of lumber and the proper number of board feet.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

e. Wood defects
   1. Knots
   2. Checks
   3. Splits
   4. Warp
   5. Crown

f. Lumber measurements
   1. Running or lineal feet
   2. Board feet

g. Plywood
   1. Veneer
   2. Exterior grade
   3. Interior grade

h. Wood selection

i. Wood frame construction

j. Wooden stains
   1. Rise
   2. Run
   3. Treads
   4. Risers
   5. Stringers

k. Wood joints

l. Preservation and protection of wood
   1. Fillers or sealers
   2. Stains

m. Industrial applications
   1. Tanks and vats
   2. Ladders
   3. Stairs
   4. Decks and floors
   5. Scaffolding

n. Fasteners
   1. Glues
   2. Adhesives
   3. Nails
   4. Screws

TASK

POM-11 Identifying adhesives and tapes

PERFORMANCE OBJECTIVE

Identify adhesives and tapes.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Adhesives
   1. Assembly time
   2. Bond
   3. Cure
   4. Dry
   5. Harden
   6. Joint
   7. Pot life
   8. Set
   9. Shelf life
   10. Tuck
   11. Working time

b. General characteristics
   1. Liquids
   2. Pastes
   3. Mastic
   4. Two-part adhesives
   5. Thermosetting adhesives

(Continued on back)

Provide Demonstration On:

Applying adhesive and tape

Provide Practical Application On:

Selecting an adhesive or tape and applying it for a given job

INSTRUCTIONAL MATERIALS

Textbooks:

Smith, Materials of Construction

Student Manuals:

Plant Engineering Training Systems, Non-Metal Materials, Lesson Ten

LAB HOURS 4

CLASS HOURS 1

EVALUATION (POM-11)

Given a material that requires bonding, the student will select the appropriate adhesive or tape and describe the process which completes the bond. The completed task must be in compliance with the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

c. Animal glues
d. Casein glues
e. Vegetable glues
f. Synthetic resin glues
g. Repairs with plastic resin adhesives
h. Plastic welding
i. Acrylic based adhesives
j. Special adhesives
    1. Structural adhesives
    2. Anaerobic adhesives
k. Tapes
    1. Masking tape
    2. Duct-seal tape
    3. High-temperature tape
    4. Freezer tape
    5. Double-coated tape
    6. Heat-shrinkable tape
    7. Foam-backed tape

TASK

POM-12 Identifying basic principles of lubrication

PERFORMANCE OBJECTIVE

Identify basic principles of lubrication.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Lubrication
b. Basic purposes of lubricants
    1. Reduce friction
    2. Reduce wear
    3. Dampen shock
    4. Cool moving elements
    5. Prevent corrosion
    6. Seal out contaminants
c. Classifications of lubricants
    1. Liquid
    2. Semi-solid
    3. Solid
    4. Gas
d. Sliding and rolling friction
e. Types of motion
    1. Rotary
    2. Linear
    3. Combination
f. Wear
g. Dampening shock
h. Cooling action of lubricants
i. Corrosion prevention
j. Lubricants as seals
k. Other actions of lubricants
    1. Flushing action
    2. Power transmission

INSTRUCTIONAL MATERIALS

Textbooks:

McGraw-Hill, Standard Handbook of Lubrication

A/Vs:

AAVIM, "Selecting and Storing Fuels and Lubricants," slide/tape

Student Manuals:

Plant Engineering Training Systems, Lubrication, Lesson One

LAB HOURS	4
CLASS HOURS	1

EVALUATION (POM-12)

Given an overview of lubricants and their applications, the student will accurately identify basic principles of lubricants and identify their applications.

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TASK

POM-13 Identifying oils and their applications

PERFORMANCE OBJECTIVE

Identify oils and describe their applications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Oils
   1. Load, temperature, speed and environment
   2. Animal oils
   3. Mineral oils
   4. General or special purpose
   5. Additives
b. Oil bases
   1. Paraffin-base
   2. Napthenic-base
   3. Asphaltic-base
   4. Mixed base
c. Equipment
d. Types of oil lubricants
   1. Circulating oils
   2. Gear oils

(Continued on back)

Provide Practical Application On:

Identifying the type of oil for a particular type of machine

INSTRUCTIONAL MATERIALS

Textbooks:

McGraw-Hill, Standard Handbook of Lubrication Engineering

Student Manuals:

Plant Engineering Training Systems, Lubrication, Lesson Four

LAB HOURS 4

CLASS HOURS 1

EVALUATION (POM-13)

Given specifications for a machine, the student will accurately identify the type of oil used and its application.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

    3. Machine engine oils
    4. Spindle oils
    5. Refrigeration oils
    6. Steam-cylinder oils
e. Steel-mill circulating oils
f. Heavy-duty internal combustion engine oils
g. Gear oils
h. Machine and engine oils
    1. Light way oil
    2. Medium way oil
    3. Heavy way oil
i. Spindle oils
j. Refrigeration oils
k. Steam cylinder oils
l. Additional oil applications
    1. Electric motors
    2. Chains
    3. Special purpose oils

TASK

POM-14 Identifying general purpose greases

PERFORMANCE OBJECTIVE

Identify general purpose greases and describe their applications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Defining greases
    1. Hardness
    2. Dropping point
    3. Pumpability
    4. Water resistance
    5. Stability
b. Elements of grease
    1. Oil
    2. Thickening agent
    3. Additives
c. Characteristics of grease
    1. Base
    2. Dropping point
    3. Penetration
d. Additional characteristics of grease
    1. Texture

(Continued on back)

Provide Practical Application On:

Identifying several types of greases and describe their applications

INSTRUCTIONAL MATERIALS

Textbooks:

McGraw-Hill, Standard Handbook of Lubrication Engineering

Student Manuals:

Plant Engineering Training Systems, Lubrication, Lesson Five

Tools and Equipment:

Several types of grease

LAB HOURS	4
CLASS HOURS	1

EVALUATION (POM-14)

Given several types of greases, the student will correctly identify the type of grease and describe its applications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

    2. Temperature
- e. Lubricating action of grease
- f. Reasons for using grease
    1. Applications where lubricant can't drip
    2. Inaccessibility of parts
    3. High operating temperatures
    4. Sealing out contaminants
- g. How greases are made
    1. Cold made grease
    2. Heating or "cooking"
- h. Types of greases
    1. Mixtures of mineral oils
    2. Heavy, asphaltic type oils
    3. Extreme pressure greases
    4. Soap-thickened mineral oils
- i. Common soaps
    1. Calcium
    2. Sodium
    3. Barium
    4. Lithium
    5. Strontium
    6. Lead
- j. Applications
    1. Plain bearing greases
    2. Anti-friction bearings and grease
    3. Bearing re-lubrication

TASK

POM-15 Identifying lubricating compounds

PERFORMANCE OBJECTIVE

Identify and describe lubricating compounds.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Use of compounds
b. Types of compounds
    1. Natural
    2. Synthetic
c. Liquid lubricants
    1. Petroleum oils
    2. Vegetable oils
    3. Fish oils
d. Petroleum base oils
    1. Paraffin-base
    2. Mapthenic-base
    3. Mixed base
e. Synthetic liquid lubricants
f. Monoester
    1. Monobasic acids
    2. Monohydric alcohols

(Continued on back)

Provide Practical Application On:

Describing the compounds used in various types of oils and greases

INSTRUCTIONAL MATERIALS

Textbooks:

McGraw-Hill, Standard Handbook of Lubrication Engineering

Student Manuals:

Plant Engineering Training Systems, Lubrication, Lesson Seven

Tools and Equipment:

a. Oils
b. Greases

LAB HOURS 4
CLASS HOURS 1

EVALUATION (POM-15)

Given an oil or a grease, the student will correctly identify and describe the structure of the compounds.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

g. Dibasic acid esters
h. Phosphate ester
i. Silicone polymers
j. Silicate esters
k. Solid lubricants
    1. Inorganic
    2. Organic
    3. Metal film lubricants
l. Laminar solids
    1. Graphite
    2. Tungsten disulfide
    3. Mica
    4. Boron nitride
    5. Borax
    6. Cadmium ioxide
m. Soft solids
n. Chemical coatings
    1. Sulfide
    2. Chloride
    3. Oxide
    4. Oxalate
o. Organic compounds
    1. Soaps
    2. Fats
    3. Waxes
p. Polymers

TASK

POM-16 Identifying hydraulic fluids

PERFORMANCE OBJECTIVE

Identify hydraulic fluids.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Functions of hydraulic fluids
b. Physical properties of hydraulic fluids
c. Viscosity
    1. Saybolt Universal Seconds (SUS)
    2. American Society for Testing Materials (ASTM)
    3. Viscosity and pressure
d. Pour point
e. Fluid selection
f. Effects of too low/too high fluid levels
g. Component protection
h. Chemical properties

(Continued on back)

Provide Practical Application On:

Identifying types of hydraulic fluids

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, *Basic Fluid Power*
b. Pippenger and Hicks, *Industrial Hydraulics*
c. Delmar, *Electromechanical Technology Series, Fluids*

Student Manuals:

Plant Engineering Training Systems, *Basic Hydraulics, Lesson Two*

Tools and Equipment:

Examples of types of hydraulic fluid

LAB HOURS 4
CLASS HOURS 1

EVALUATION (POM-16)

Given a hydraulic fluid, the student will describe the fluid in terms of viscosity, chemical properties and fluid type. The completed task must be rated as acceptable according to the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

i. System contamination
    1. Water - demulsification, vapor pressure
    2. Dissolved air
    3. Foaming
    4. Corrosion and rusting
j. Hydraulic fluid types
    1. Petroleum oils
    2. Oil-in-water emulsions
    3. Water-in-oil emulsions
    4. Water base glycols
    5. Chlorinated hydrocarbons
    6. Phosphate esters
    7. Silicones
    8. Silicate esters

TASK

MFP-01 Identifying practical applications of power

PERFORMANCE OBJECTIVE

Identify practical applications of power.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Types of power
    1. Electrical
    2. Pneumatic
    3. Hydraulic
    4. Steam
    5. Internal combustion engines
b. Methods of producing power
    1. Steam turbine
    2. Internal combustion engine
    3. Hydraulic and pneumatics motors
c. Mechanical efficiency
    1. Percentage efficiency
    2. Matching power to the job
d. Compound machines and gearing
    1. Simple gears
    2. Norm gear reducer
e. Selecting a crane reducer
f. Finding gear ratios and work forces
g. Determining work done by a crane hook
h. Word and speed of a fork-lift truck speed
i. Work done tightening a bolt

INSTRUCTIONAL MATERIALS

Student Manuals:

Plant Engineering Training Systems, Elements of Mechanics, Lesson Five

LAB HOURS	2
CLASS HOURS	1

EVALUATION (MFP-01)

Given a type of power and a method of producing that power, the student will accurately identify practical applications of that power. Answers will be graded according to the instructor's requirements.

TASK

MFP-02 Identifying pneumatic principles

PERFORMANCE OBJECTIVE

Identify basic principles of pneumatics.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Pneumatic power systems
   1. Pneumatic tools
   2. Linear motion devices
   3. Door openers
   4. Rotary motion devices
b. Force, weight and mass
c. Pressure
   1. Atmospheric
   2. Below atmospheric
   3. Pneumatic system pressure
d. Work and energy
e. Power
f. Energy used in pneumatic systems
   1. Electrical
   2. Pneumatic
   3. Kinetic
   4. Potential
   5. Heat
g. Diffusion and dispersion
h. Separation of gases and liquids
i. Compressibility
j. Pneumatic laws
   1. Pascal's law
   2. Boyle's law
   3. Charles law
   4. Ideal Gas law
k. Transmission of pneumatic fluid power
l. Pneumatic leverage
m. Air properties
n. Air flow in pipes
o. Viscosity of air
p. Bernoulli's Principle
q. Pneumatic power systems

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

A/Vs:

Bobbs-Merrill, "Fluid Power," transparencies

Student Manuals:

a. Plant Engineering Training Systems, Basic Pneumatics, Lesson One
b. Bobbs-Merrill, Fluid Power

LAB HOURS 3

CLASS HOURS 1

EVALUATION MFP-02)

Given an overview of basic pneumatic power system principles, the student will correctly identify basic pneumatic principles and terminology.

TASK

MFP-03 Identifying reciprocating compressors

PERFORMANCE OBJECTIVE

Identify and describe reciprocating compressors.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Compressor operation
b. Compressor classification
    1. Positive displacement
    2. Dynamic
c. Reciprocating piston compressors
d. Single and double-acting compressors
e. Compressor construction
f. Horsepower cooling requirements
    1. Intercooling
    2. Aftercooler
    3. Water-cooled
    4. Counter-flow
    5. Parallel flow

(Continued on back)

Provide Practical Application On:

Identifying types of reciprocating compressors in the lab or in a plant

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

A/Vs:

Bobbs-Merrill, "Fluid Power," transparencies

Student Manuals:

a. Plant Engineering Training Systems, Basic Pneumatics, Lesson Two
b. Bobbs-Merrill, Fluid Power

Tools and Equipment:

Several types of reciprocating compressors

LAB HOURS 3

CLASS HOURS 1

EVALUATION (MFP-03)

Given a reciprocating compressor, the student will accurately identify the type of compressor and describe it in terms of controls, lubrication requirements and application.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

g. Compressor lubrication
    1. Reduce friction
    2. Improve transfer of heat
    3. Splash or pressurized
h. Non-lubricated compressors
i. Compressor controls
    1. Unloading
    2. Holding type
    3. Suction unloader valves
    4. Centrifugal pressure release
    5. Electric or magnetic unloader

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TASK

MFP-04 Identifying rotary compressors

PERFORMANCE OBJECTIVE

Identify rotary compressors.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Compressor classification
b. Compressor selection
c. Compressor accessories

Provide Practical Application On:

Identifying rotary compressors

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

A/Vs:

Bobbs-Merrill, "Fluid Power," transparencies

Student Manuals:

a. Plant Engineering Training Systems, Basic Pneumatics, Lesson Three
b. Bobbs-Merrill, Fluid Power

Tools and Equipment:

Selection of several rotary compressors

LAB HOURS	3
CLASS HOURS	1

EVALUATION (MFP-04)

Given a rotary compressor, the student will accurately classify the compressor and describe its operation and application.

TASK

MFP-05 Identifying primary air treatment in pneumatic systems

PERFORMANCE OBJECTIVE

Identify the method of primary air treatment in a pneumatic system.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Air treatment
b. Preliminary filtering
   1. Dry or wet filters
   2. Cleaning a filter
c. Relative humidity
   1. Temperature
   2. Weather
   3. Air pressure
d. Effects of moisture
e. Water removal
   1. Condensers after coolers
   2. Water and air cooled
f. Dew point
g. Moisture separators
   1. Gravity separation
   2. Drain plugs - safety

(Continued on back)

Provide Practical Application On:

Identifying methods of air treatment in a pneumatic system

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

A/Vs:

Bobbs-Merrill, "Fluid Power," transparencies

Student Manuals:

a. Plant Engineering Training Systems, Basic Pneumatics, Lesson Four
b. Bobbs-Merrill, Fluid Power

Tools and Equipment:

Diagram of a pneumatic system

LAB HOURS 3

CLASS HOURS 1

EVALUATION (MFP-05)

Given a pneumatic system, the student will accurately identify and describe air treatment methods.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

h. Oil scrubbers
    1. Operation
    2. Maintenance
i. Air dryers
    1. Deliquescent
    2. Adsorption
j. Air receivers

TASK

MFP-06 Identifying secondary air treatment methods

PERFORMANCE OBJECTIVE

Identify secondary air treatment methods.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Methods of treatment
b. Contaminant separation
c. Contaminant filtration
d. Filter classification and rating
e. Types of medium surface filters
f. Depth filters
g. Absorption filters
h. Lubricating

Provide Practical Application On:

Identifying secondary air treatment methods used on a pneumatic system

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

A/Vs:

Bobbs-Merrill, "Fluid Power," transparencies

Student Manuals:

a. Plant Engineering Training Systems, Basic Pneumatics, Lesson Five
b. Bobbs-Merrill, Fluid Power

Tools and Equipment:

Diagram or live pneumatic system

LAB HOURS	3
CLASS HOURS	1

EVALUATION (MFP-06)

Given a pneumatic system, the student will accurately identify and describe secondary air treatment methods.

TASK

MFP-07 Identifying piping, hoses and fittings used in pneumatic systems

PERFORMANCE OBJECTIVE

Identify the types of piping, hoses and fittings used in a pneumatic system.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Piping requirements
    1. Pipe, tubing, hose and fitting combinations
    2. Free of leaks
b. Air flow
    1. Streamlined
    2. Lominar flow
    3. Selection of pipe size
c. Piping
    1. Black steel pipe
    2. Bursting pressure
    3. Safety factor
    4. Threading, welding and flanging
d. Pipe applications
e. Metallic tubing

(Continued on back)

Provide Practical Application On:

Installing pipes, tubes or hoses on a pneumatic system

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

A/Vs:

Bobbs-Merrill, "Fluid Power," transparencies

Student Manuals:

a. Plant Engineering Training Systems, Basic Pneumatics, Lesson Six
b. Bobbs-Merrill, Fluid Power

Tools and Equipment:

a. Pipe
b. Tube
c. Hose
d. Fittings and couplings
e. Tools

LAB HOURS	4
CLASS HOURS	2

EVALUATION (MFP-07)

Given appropriate tools, supplies and equipment, the student will accurately use the correct procedure to install pipe, hoses and tubing on a pneumatic system.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

f. Tube bending
g. Tube fittings
h. Installation of tube
i. Non-metallic tubing
j. Hoses and fittings
k. Hose installation

TASK

MFP-08 Identifying control valves

PERFORMANCE OBJECTIVE

Identify control valves.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Control valves
b. Manually operated valves
c. Automatically operated valves
d. Checking valves
    1. Flapper
    2. Poppet
    3. Ball
    4. Cracking pressure
e. Self-activated shuttle valves
f. Control valves
    1. Spool
    2. Poppet
    3. Reciprocating disc
    4. Rotary
g. Three-way valves
h. Four-way valves

(Continued on back)

Provide Practical Application On:

Identifying types of valves from diagrams or live examples

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

A/Vs:

Bobbs-Merrill, "Fluid Power," transparencies

Student Manuals:

a. Plant Engineering Training Systems, Basic Pneumatics, Lesson Seven
b. Bobbs-Merrill, Fluid Power

Tools and Equipment:

Valves or diagrams of different types of valves

LAB HOURS 3
CLASS HOURS 1

EVALUATION (MFP-08)

Given a control valve or diagram, the student will correctly identify the valve and describe its purpose.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

i. Five-way valves
j. Valve accessories

TASK

MFP-09 Identifying pressure relief valves

PERFORMANCE OBJECTIVE

Identify pressure relief valves used in pneumatic systems.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Controlling pressure
b. Safety valves
c. Relief valves
d. Refill valve construction
e. Pressure regulators
f. Regulator modifications
g. Safety

Provide Demonstration On:

Setting or adjusting a regulator

Provide Practical Application On:

Identifying, setting or adjusting a regulator

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, *Basic Fluid Power*
b. Stewart and Storer, *Fluid Power*

A/Vs:

Bobbs-Merrill, "Fluid Power," transparencies

Student Manuals:

a. Plant Engineering Training Systems, *Basic Pneumatics, Lesson Eight*
b. Bobbs-Merrill, *Fluid Power*

LAB HOURS 3
CLASS HOURS 1

EVALUATION (MFP-09)

Given a pneumatic system with a pressure regulator, the student will correctly identify, set or adjust the valve according to the appropriate specifications.

TASK

MFP-10 Identifying cylinders

PERFORMANCE OBJECTIVE

Identify cylinders used for pneumatic systems.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Pneumatic cylinders
b. Double-acting cylinders
c. Single-acting cylinders
d. Two-piston cylinders
e. Rod packings
f. Mounting
g. Selecting a cylinder
h. Cushioning
i. Piston rod strength

Provide Practical Application On:

Selecting a cylinder for a pneumatic system

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

A/Vs:

Bobbs-Merrill, "Fluid Power," transparencies

Student Manuals:

a. Plant Engineering Training Systems, Basic Pneumatics, Lesson Nine
b. Bobbs-Merrill, Fluid Power

Tools and Equipment:

a. Cylinders and specifications
b. Pneumatic system

LAB HOURS	3
CLASS HOURS	1

EVALUATION (MFP-10)

Given a pneumatic system and specifications, the student will correctly select the correct capacity cylinder for use with the system.

TASK

MFP-11 Identifying motors

PERFORMANCE OBJECTIVE

Identify motors used on a pneumatic system.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Pneumatic motors
b. Motor classification
    1. Piston motors
    2. Vane motors
    3. Positive displacement
c. Rating and selection factors
    1. Pressure rating
    2. Speed range
    3. Torque
    4. Horsepower
    5. Size, weight and mounting
d. Motor construction
e. Piston motors
f. Rotary activators
g. Portable air tools
h. Air boosters

Provide Practical Application On:

Selecting a motor and installing it on a pneumatic system

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

A/Vs:

Bobbs-Merrill, "Fluid Power," transparency

Student Manuals:

a. Plant Engineering Training Systems, Basic Pneumatics, Lesson Ten
b. Bobbs-Merrill, Fluid Power

Tools and Equipment:

a. Motors
b. Pneumatic system
c. Tools

LAB HOURS	3
CLASS HOURS	1

EVALUATION (MFP-11)

Given a pneumatic system and specifications, the student will accurately select an appropriately rated motor and install the motor on the system.

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TASK

MFP-12 Identifying components of pneumatic systems

PERFORMANCE OBJECTIVE

Identify the components of a pneumatic system.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. The penumatic system
    1. Components
    2. Power
b. The air supply system
c. Reciprocating compressors
    1. Single-acting
    2. Double-acting
    3. Multi-stage
    4. Piston displacement
d. Regulation and control
    1. Unloading mechanisms
    2. Suction valve unloading
    3. Clearance pocket unloading
    4. Throttling the intake

(Continued on back)

Provide Practical Application On:

Identifying components of a pneumatic system

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

A/Vs:

Bobbs-Merrill, "Fluid Power," transparency

Student Manuals:

Plant Engineering Training Systems, Pneumatic Troubleshooting, Lesson One

Tools and Equipment:

Diagram of a pneumatic system

LAB HOURS	3
CLASS HOURS	1

EVALUATION (MFP-12)

Given a diagram of a pneumatic system, the student will accurately identify the components and describe their functions.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

e. Rotary compressors
    1. Sliding vane
    2. Rotary screw
    3. Impeller
    4. Liquid ring
    5. Diaphragm
f. Cooling
    1. Intercooling
    2. After cooling
g. Compressor preventive maintenance
h. The delivered air system
    1. Filters/separators
    2. Absorption drying
i. Air line filters
j. Air line lubrication

TASK

MFP-13 Reading pneumatic schematic diagrams

PERFORMANCE OBJECTIVE

Read and interpret a penumatic schematic diagram.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Types of symbols
   1. Pictorial
   2. Cutaway
   3. Schematic
b. Constructing symbols
   1. Basic symbols
   2. Functional symbols
   3. Complete, simplified and composite
c. Diagramming an air supply system
   1. A simple system
   2. Timing circuits
   3. Safety circuits
d. Symbols for special devices
e. Reading a system schematic

Provide Demonstration On:

Finding the direction of flow on a pneumatic diagram

Provide Practical Application On:

Reading a pneumatic diagram and interpreting it

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

Student Manuals:

Plant Engineering Training Systems, Pneumatic Troubleshooting, Lesson Two

Tools and Equipment:

Pneumatic schematic diagrams

LAB HOURS	3
CLASS HOURS	1

EVALUATION (MFP-13)

Given a schematic diagram of a pneumatic system, the student will accurately read the diagram and interpret all symbols including the direction of flow.

TASK

MFP-14 Installing system components

PERFORMANCE OBJECTIVE

Install components on a pneumatic system.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Compressor and auxiliaries
    1. Air intake failures
    2. Location of compressor
    3. Installation requirements
b. Compressor intakes
    1. Location
    2. Mounting
    3. Filter
c. Compressor foundations
d. After coolers
e. Receivers
f. Dryers
g. Pipe installation
    1. Pipe support
    2. Pipe threads

(Continued on back)

Provide Practical Application On:

Installing a given component on a pneumatic system

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

A/Vs:

Bobbs-Merrill, "Fluid Power," transparency

Student Manuals:

Plant Engineering Training Systems, Pneumatic Troubleshooting, Lesson Three

Tools and Equipment:

a. Pneumatic components
b. Installation tools and supplies

LAB HOURS 4

CLASS HOURS 1

EVALUATION (MFP-14)

Given a component of a pneumatic system, the student will accurately install the component on the pneumatic system. Correct procedures and all safety recommendations must be adhered to by the student.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

    3. Tubing
    4. Tube fittings
    5. Hose installation
h. Control systems
    1. Control valve installation
    2. Solenoid coils
i. Cylinder installation
j. Safety

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TASK

MFP-15 Identifying procedures for pneumatic system maintenance

PERFORMANCE OBJECTIVE

Identify procedures for maintenance of a pneumatic system.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Planning maintenance
   1. Lubrication
   2. Adjustment
   3. Preventive maintenance
b. Compressor room maintenance
   1. Compressor load
   2. Intake air filter
   3. Crankcase oil level
   4. Belts or belt driven units
c. System maintenance
   1. Drains and moisture traps
   2. Filters and separations
   3. Air pressure

(Continued on back)

Provide Demonstration On:

Developing a maintenance log

Provide Practical Application On:

Developing a maintenance log

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

Student Manuals:

Plant Engineering Training Systems, Pneumatic Troubleshooting, Lesson Four

LAB HOURS 3

CLASS HOURS 1

EVALUATION (MFP-15)

Given a pneumatic system, the student will correctly identify procedures for maintaining the system and for setting up and keeping maintenance records.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

d. Control system maintenance
    1. Shutting off the system for maintenance
    2. Regulators
    3. Cylinders
e. Tool maintenance
    1. Reasonable handling
    2. Lubrication
f. Keeping a maintenance log

TASK

MFP-16 Determining system failures

PERFORMANCE OBJECTIVE

Determine the cause of failure in a pneumatic system.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Understanding the system
b. Troubleshooting procedure
c. Locating troubles
d. Using the operations manual
e. Checking the air supply
f. Troubleshooting the actuator
g. Checking the control valve
h. Checking a control valve actuator
i. Checking sequence valves
j. Checking master control valve
k. Checking interlocks
l. Making final adjustments and operating the system

Provide Practical Application On:

Troubleshooting a pneumatic system

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, *Basic Fluid Power*
b. Stewart and Storer, *Fluid Power*

Student Manuals:

Plant Engineering Training Systems, *Pneumatic Troubleshooting, Lesson Five*

Tools and Equipment:

a. Schematic of system
b. Operations manual

LAB HOURS	5
CLASS HOURS	1

EVALUATION (MFP-16)

Given a defective pneumatic system, the student will accurately troubleshoot the system, correct the problem and operate the system to test for proper operation.

TASK

MFP-17 Troubleshooting air compressors

PERFORMANCE OBJECTIVE

Troubleshoot air compressors.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Reciprocating compressor cooling
b. Compressor lubrication
c. Compressor valves
d. Crankcase ventilation
e. Piston rings and bearings
f. Control systems
g. Rotary compressors
h. Vane compressors
i. Rotary screw compressors
j. Centrifugal compressors

Provide Practical Application On:

Troubleshooting and repairing a faulty compressor

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

Student Manuals:

Plant Engineering Training Systems, Pneumatic Troubleshooting, Lesson Six

LAB HOURS	5
CLASS HOURS	1

EVALUATION (MFP-17)

Given a faulty air compressor, the student will accurately troubleshoot the compressor and repair it to normal operation.

TASK

MFP-18 Troubleshooting control valves

PERFORMANCE OBJECTIVE

Troubleshoot control valves on a pneumatic system and repair them.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Troubleshooting controls
   1. Non-starting
   2. Improper sequencing
   3. Miscellaneous equipment related problems
b. Troubleshooting a circuit that won't start
   1. Electric power
   2. Pneumatic power
   3. Manual overrides
   4. Sequence
   5. Lockouts
   6. Mechanical interference
   7. Solenoids
c. Checking manual overrides
d. Checking for lockouts

(Continued on back)

Provide Practical Application On:

Troubleshooting and repairing a faulty control valve

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

Student Manuals:

Plant Engineering Training Systems, Pneumatic Troubleshooting, Lesson Seven

LAB HOURS	5
CLASS HOURS	1

EVALUATION (MFP-18)

Given a pneumatic system with a faulty control valve, the student will troubleshoot the valve and correct the problem according to the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

e. Checking circuit sequence
f. Checking for mechanical interference
g. Checking electrical solenoids
h. Troubleshooting improper sequence operation
i. Improper valve shifting
j. Changes in control timing
k. Miscellaneous problems
l. Lubrication problems

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TASK

MFP-19 Troubleshooting cylinders

PERFORMANCE OBJECTIVE

Troubleshoot cylinders in a pneumatic system.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Cylinders
    1. Purpose
    2. Construction
    3. Pistons
    4. Piston rings, "O" rings
b. Cylinder troubleshooting and repair
    1. Checking cylinder size
    2. Proper air pressure
    3. Misalignment
    4. Worn packings and seals
    5. General installation
    6. Speed controls

Provide Practical Application On:

Troubleshooting and repairing or replacing a faulty cylinder

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

Student Manuals:

Plant Engineering Training Systems, Pneumatic Troubleshooting, Lesson Eight

LAB HOURS	5
CLASS HOURS	1

EVALUATION (MFP-19)

Given a pneumatic system with a faulty cylinder, the student will accurately troubleshoot and replace or repair the cylinder. The completed work must meet the instructor's specifications.

TASK

MFP-20 Troubleshooting air motors

PERFORMANCE OBJECTIVE

Troubleshoot air motors on a pneumatic system.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Uses of air motors
b. Checking for sufficient air
c. Contaminated air
d. Lubrication
e. Air motor abuse
f. Hon and clamp maintenance
g. Air motor troubleshooting
h. Vane motors
i. Radial piston motor
j. Axial piston air motors
k. Percussion tools
l. Safety

Provide Practical Application On:

Troubleshooting a faulty air motor and repairing it

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

Student Manuals:

Plant Engineering Training Systems, Pneumatic Troubleshooting, Lesson Nine

LAB HOURS 5
CLASS HOURS 1

EVALUATION (MFP-20)

Given a faulty air motor, the student will accurately troubleshoot and repair the motor according to the instructor's specifications.

TASK

MFP-21 Troubleshooting a pneumatic and hydraulic system

PERFORMANCE OBJECTIVE

Troubleshoot a pneumatic and hydraulic system.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Air oil tanks
b. Air hydraulic boosters
c. Pressure boosters
d. Single-pressure booster systems
e. Dual-pressure booster systems
f. Hydraulic control cylinders
g. Fast advance cylinders
h. Combined air foil cylinders
i. Pneumatic cushioning
j. Air hydraulic system interlock
k. Pneumatic service

Provide Practical Application On:

Troubleshooting and repairing a pneumatic and hydraulic system

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Stewart and Storer, Fluid Power

Student Manuals:

Plant Engineering Training Systems, Pneumatic Troubleshooting, Lesson Ten

LAB HOURS	5
CLASS HOURS	1

EVALUATION (MFP-21)

Given a defective system which is both pneumatically and hydraulically operated, the student will correctly identify the system, troubleshoot the problem and repair it according to the instructor's specifications.

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TASK

MFP-22 Identifying metal manufacturing processes

PERFORMANCE OBJECTIVE

Identify metal manufacturing processes.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Methods of casting
    1. Sand
    2. Centrifugal
    3. Permanent-mold
    4. Die
b. Permanent-mold casting
c. Centrifugal casting
    1. Application
    2. Procedure
d. Die casting
    1. Hot chamber
    2. Cold chamber
e. Die forging
f. Extrusion
    1. Procedure
    2. Advantages
g. Cold forging steel
    1. Upsetting or heading
    2. Header
    3. Applications
h. Processing metal powders
    1. Electroforming
    2. Powder metallurgy
    3. Metal powder products
i. Stretching, shearing, bending
j. Wire drawing
    1. Material used
    2. Pickling
    3. Sulling

INSTRUCTIONAL MATERIALS

Textbooks:

a. Feirer, General Metals
b. Harold V. Johnson, Technical Metals

A/Vs:

Career Aids, Inc., "Foundry Work," filmstrip/cassette

Student Manuals:

Plant Engineering Training Systems, Metal Materials, Lesson Four

LAB HOURS	3
CLASS HOURS	1

EVALUATION (MFP-22)

Given a specified metal manufacturing process, the student will identify the process, describe the steps in the process and identify the purpose of the process in terms of products.

TASK

MFP-23 Identifying strainers and filters in hydraulic systems

PERFORMANCE OBJECTIVE

Identify strainers and filters in a hydraulic system.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Hydraulic system requirements
b. Removing contaminants
c. Degree of filtration
    1. Nominal
    2. Absolute
    3. Particle
d. Performance characteristics
e. Performance of different mediums
f. Strainers
    1. Mesh
    2. Primary use
    3. Reservoir strainers
    4. In line strainers

(Continued on back)

Provide Practical Application On:

Identifying several types of filters and strainers

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Pippenger and Hicks, Industrial Hydraulics
c. Delmar, Electromechanical Technology Series, Fluids

Student Manuals:

Plant Engineering Training Systems, Basic Hydraulics, Lesson Three

Tools and Equipment:

Several types of filters and strainers

LAB HOURS 3
CLASS HOURS 1

EVALUATION (MFP-23)

Given a selection of filters and strainers, the student will identify and describe each type and its function. The completed task must meet the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

g. Filters
h. Fiber mediums
i. Magnetic mediums
j. Filter and strainer installations

TASK

MFP-24 Identifying reservoirs and accumulators in a hydraulic system

PERFORMANCE OBJECTIVE

Identify reservoirs and accumulators in a hydraulic system.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. System demands
   1. Function of a reservoir
   2. Function of an accumulator
b. Fluid reservoir requirements
   1. Storing a supply of hydraulic fluid
   2. Breaking up foam
   3. Settling heavy dirt, sludge and water
   4. Cooling the fluid
   5. Mounting platform for pump and other equipment
c. Baffles
d. Air separation
e. Reservoir cooling
f. Liquid heat exchanger
g. Reservoir accessories
   1. Pump intake strainers
   2. Suction gage
   3. Air breather
   4. Fluid level gage
   5. Thermometer
   6. The reservoir as support base for the power unit
h. Accumulators
   1. Stores fluid under pressure until needed by system
   2. Absorbs hydraulic shocks

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Pippenger and Hicks, Industrial Hydraulics
c. Delmar, Electromechanical Technology Series, Fluids

Student Manuals:

a. Plant Engineering Training Systems, Basic Hydraulic, Lesson Four
b. Oregon, Reservoirs

Tools and Equipment:

Hydraulic system (or diagram)

LAB HOURS 3
CLASS HOURS 1

EVALUATION (MFP-24)

Given a hydraulic system, the student will identify reservoirs and accumulators and describe their purposes. The completed task must be rated as acceptable according to the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

i. Types of accumulators
    1. Weight loaded or gravity
    2. Spring-loaded piston
    3. Air bottle or non-separated gas
    4. Bladder or bag
    5. Diaphragm
    6. Gas charged piston
    7. Differential piston

TASK

MFP-25 Identifying hydraulic pumps on a system

PERFORMANCE OBJECTIVE

Identify pumps on a hydraulic system.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

- a. Purpose of hydraulic pumps
- b. Pump classifications
  - 1. Positive displacement
  - 2. Non-positive displacement
  - 3. Fixed or variable
  - 4. Rotary
  - 5. Piston
  - 6. Radial piston
- c. Rating selection factors
  - 1. Capacity
  - 2. Pressure
  - 3. Drive speed
  - 4. Efficiency
  - 5. Reliability
  - 6. Fluid characteristics
  - 7. Size and weight

(Continued on back)

Provide Practical Application On:

Identifying types of pumps from live examples, illustrations or diagrams

INSTRUCTIONAL MATERIALS

Textbooks:

- a. Pease, Basic Fluid Power
- b. Pippenger and Hicks, Industrial Hydraulics
- c. Delmar, Electromechanical Technology Series, Fluids

Student Manuals:

- a. Plant Engineering Training Systems, Basic Hydraulics, Lesson Five
- b. Oregon, Pumps

Tools and Equipment:

Pumps (live examples, illustrations or diagrams)

LAB HOURS 3

CLASS HOURS 1

EVALUATION (MFP-25)

Given diagrams of pumps, the student will accurately identify the type of pump and describe its use.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

    8. Control adaptability
    9. Life
    10. Installation and maintenance
d. Gear pumps
    1. External
    2. Internal
    3. Axial flow or screw
    4. Cycloidal
e. Vane pumps
f. Piston pumps
    1. Dexial piston
    2. Radial pistons
    3. Inlet and outlet check valve

TASK

MFP-26 Identifying piping, tubing and fittings

PERFORMANCE OBJECTIVE

Identify piping, tubing and fittings used in hydraulic systems.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Hydraulic piping
b. Flow and velocity
    1. Laminar flow
    2. Velocity = $\frac{\text{flow (gpm)} \times 0.321}{\text{pipe area (sq. in.)}}$
c. Hydraulic pressure
d. Pressure loss
e. Pipe fittings
f. Threaded pipe
g. Installing pipe
h. Tubing
    1. Tube bending
    2. Tube fittings
i. Hoses

Provide Practical Application On:

Choosing the correct size pipe, fitting, coupling or hose for a job

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Pippenger and Hicks, Industrial Hydraulics
c. Delmar, Electromechanical Technology Series, Fluids

Student Manuals:

Plant Engineering Training Systems, Basic Hydraulics, Lesson Six

LAB HOURS 3
CLASS HOURS 1

EVALUATION (MFP-26)

Given specifications for a job, the student will select the correct size pipe, fitting, coupling or hose and prepare the job for installation. The completed task must be in accordance with the instructor's specifications.

TASK

MFP-27 Identifying directional control valves

PERFORMANCE OBJECTIVE

Identify directional control valves used in a hydraulic system.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Purpose of directional control valves
b. Manually operated valves
    1. Globe
    2. Plug
    3. Ball
    4. Needle
c. Automatic two-way valves
    1. Direct-acting
    2. Normally closed
    3. Pilot operated
d. Checking valves
e. Fluid motor control.
f. Normally open and normally closed three-way valves
g. Holding valves

(Continued on back)

Provide Practical Application On:

Identifying types of directional control valves on a diagram of a hydraulic system

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Pippenger and Hicks, Industrial Hydraulics
c. Delmar, Electromechanical Technology Series, Fluids

Student Manuals:

a. Plant Engineering Training Systems, Basic Hydraulics, Lesson Seven
b. Oregon, Directional Control Valve

Tools and Equipment:

Diagram of a hydraulic system

LAB HOURS 3

CLASS HOURS 1

EVALUATION (MFP-27)

Given a diagram of a hydraulic system, the student will accurately identify the types of directional control valves on the system.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

h. Four-way valves
i. Five-way valves
j. Rotary valves
k. Valve actuators
l. Special valves and accessories

TASK

MFP-28 Identifying pressure control valves

PERFORMANCE OBJECTIVE

Identify pressure control valves.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Pressure control valves
   1. Purpose
   2. Flow control
   3. Holding or sequence valve
b. Pressure relief valve
   1. Poppet or spool type
   2. Flow capacity
   3. Operating differential pressure
c. Spool valves
   1. Simple and direct acting spool valve
   2. Two-stage or compound
   3. Remote control
d. Sequence valves
e. Counter balance valves

Provide Practical Application On:

Identifying and describing types of pressure control valves from illustrations or live examples

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Pippenger and Hicks, Industrial Hydraulics
c. Delmar, Electromechanical Technology Series, Fluids

Student Manuals:

a. Plant Engineering Training Systems, Basic Hydraulics, Lesson Eight
b. Oregon, Pressure Relief Valves

LAB HOURS 3

CLASS HOURS 1

EVALUATION (MFP-28)

Given illustrations or live examples of pressure control valves, the student will correctly identify the type of valve and describe its purpose.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

f. Holding valves
g. Unloading valves
h. Pressure reducing valves
i. Shock suppressors
j. Flow control valves
k. Pressure compensation
l. Temperature compensation

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TASK

MFP-29 Identifying cylinders in a hydraulic system

PERFORMANCE OBJECTIVE

Identify cylinders used in a hydraulic system.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Purpose of cylinders
b. Double-acting cylinders
c. Single-acting cylinder
    1. Ram
    2. Telescoping cylinders
d. Two-piston cylinders
e. Positional cylinders
f. Cylinder construction
    1. Piston rings and seals
    2. Road packing
g. Cylinder mounting
    1. Fixed
    2. Pivoted
    3. Centerline
    4. Non-centerline

(Continued on back)

Provide Practical Application On:

Selecting the appropriate cylinder for a hydraulic system

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Pippenger and Hicks, Industrial Hydraulics
c. Morrow, Maintenance Engineering Handbook
d. Delmar, Electromechanical Technology Series, Fluids

Student Manuals:

a. Plant Engineering Training Systems, Basic Hydraulics, Lesson Nine
b. Oregon, Cylinders

Tools and Equipment:

Cylinders

LAB HOURS 3
CLASS HOURS 1

EVALUATION (MFP-29)

Given specifications for a system which requires a cylinder, the student will select an appropriate cylinder for the system. The selection will be rated according to the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

h. Selecting a cylinder
i. Flow capacity
j. Cushioning
k. Piston rod strength

TASK

MFP-30 Identifying hydraulic motors

PERFORMANCE OBJECTIVE

Identify hydraulic motors.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Purpose of hydraulic motors
b. Classification of motors
   1. Positive displacement
   2. Fixed displacement
   3. Variable displacement
c. Rating and selection factors
   1. Pressure range
   2. Speed range
   3. Torque
   4. Horsepower
   5. Overall efficiency
   6. Volumetric efficiency

(Continued on back)

Provide Practical Application On:

Selecting an appropriate motor for a system

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Pippenger and Hicks, Industrial Hydraulics
c. Morrow, Maintenance Engineering Handbook
d. Delmar, Electromechanical Technology Series, Fluids

Student Manuals:

Plant Engineering Training Systems, Basic Hydraulics, Lesson Ten

Tools and Equipment:

Hydraulic motors

LAB HOURS 3

CLASS HOURS 1

EVALUATION (MFP-30)

Given specifications for a system and considering all rating factors, the student will select an appropriate motor. The selection will be rated by the instructor according to industry specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

    7. Size, weight and mounting requirements of motor
    8. Reliability and service life
d. Hydraulic motor construction
e. Gear motors
    1. External
    2. Internal
    3. Non-separated
f. Vane motors
g. Piston motors
h. Rotary actuators

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TASK

MFP-31 Troubleshooting hydraulic systems schematics

PERFORMANCE OBJECTIVE

Troubleshoot a hydraulic system.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Components of a hydraulic system
    1. Pump and drive units
    2. Actuators
    3. Control valves
    4. Conductors and connectors
    5. Hydraulic fluid
    6. Fluid storage and conditioning equipment
b. Tracing the system
    1. Getting to know the system
    2. Circuit and system diagrams
c. Mechanical set-up
d. Understanding components
e. System operation

Provide Practical Application On:

Troubleshooting a hydraulic system for a particular problem

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Pippinger and Hicks, Industrial Hydraulics

Student Manuals:

Plant Engineering Training Systems, Hydraulic Troubleshooting, Lesson One

Tools and Equipment:

Schematics of a hydraulic system

LAB HOURS	5
CLASS HOURS	1

EVALUATION (MFP-31)

Given a schematic of a hydraulic system, the student will trace the system to troubleshoot a given problem. The completed task must be in compliance with the instructor's specifications.

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TASK

MFP-32 Reading hydraulic schematic diagrams

PERFORMANCE OBJECTIVE

Read a hydraulic schematic diagram.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Types of hydraulic diagrams
b. Definition of a schematic
c. Characteristics of schematic
d. Guidelines for reading schematics
    1. Looking for flow pattern
    2. Looking for guides
    3. Reading carefully
    4. Using a step-by-step approach

(Continued on back)

Provide Practical Application On:

Reading and interpreting a schematic of a hydraulic system

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, *Basic Fluid Power*
b. Pippenger and Hicks, *Industrial Hydraulics*

Student Manuals:

Plant Engineering Training Systems, *Hydraulic Troubleshooting, Lesson Two*

LAB HOURS 3

CLASS HOURS 1

EVALUATION (MFP-32)

Given a schematic diagram of a hydraulic system, the student will interpret the system according to the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

e. Basic elements of a hydraulic system
    1. Pumps
    2. Control valves
    3. Conductors and connectors
    4. Fluid storage and conditioning equipment
    5. A hydraulic circuit

f. Sequence valve circuit

TASK

MFP-33 Installing hydraulic components

PERFORMANCE OBJECTIVE

Install components of a pump and a control valve on a hydraulic system.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Installation considerations
   1. Cleanliness
   2. Installation safety
b. Pump and drive installations
   1. Rigid mounting
   2. Styles of pumps
c. Pump start-up
   1. Checking the pump
   2. Cleanliness
   3. Proper direction of rotation
   4. Correct fluid
   5. Start pump
   6. Purging air after five minutes

(Continued on back)

Provide Practical Application On:

Installing a pump and a control valve on a hydraulic system

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, *Basic Fluid Power*
b. Pippenger and Hicks, *Industrial Hydraulics*

Student Manuals:

Plant Engineering Training Systems, *Hydraulic Troubleshooting, Lesson Three*

Tools and Equipment:

a. Pump
b. Control valve
c. Tools
d. Schematic

LAB HOURS 5

CLASS HOURS 1

EVALUATION (MFP-33)

Given appropriate tools and equipment, the student will properly install a pump and control valve on a hydraulic system. The installation must meet the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

d. Final pump start-up check
    1. Checking joints for leakage
    2. Fluid level in reservoir
    3. Fluid temperatures
    4. System pressure
    5. Spongy operation
e. Control valve installation
    1. Sub-plate connections
    2. In line threaded connections
    3. In line flanged connections
    4. Manifold
f. Extra valve ports for convenience
g. Valve port identification
h. Mechanical valve installation
i. Pneumatically actuated valves
j. Electrically controlled valves

TASK

MFP-34 Installing pipes and tubes

PERFORMANCE OBJECTIVE

Install pipes, tubes and hoses on a hydraulic system.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Conductors and connectors
   1. Pipes
   2. Tubes
   3. Hoses
b. Hydraulic pipe
c. General installation procedures
   1. Never overtightening tapered connections
   2. Never welding a fitting attached to a component
   3. Using full size pipe fittings for a component

(Continued on back)

Provide Practical Application On:

Installing pipes, tubes or hoses on a hydraulic system

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, *Basic Fluid Power*
b. Pippenger and Hicks, *Industrial Hydraulics*

Student Manuals:

Plant Engineering Training Systems, *Hydraulic Troubleshooting, Lesson Four*

Tools and Equipment:

a. Pipes
b. Tubes
c. Fittings and couplings
d. Tools

LAB HOURS 5

CLASS HOURS 1

EVALUATION (MFP-34)

Given an assignment to install pipes, tubes or hoses on a hydraulic system, the student will follow correct procedure for the installation. The procedure must be rated acceptable according to the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

    4. Never turning fittings on pipe to put tension or compression on the connector
    5. Providing support for components
    6. Counting tools when installation is finished
- d. Hydraulic tubing
    - 1. Cutting the tube
    - 2. Deburring
    - 3. Tube flaring
    - 4. Tube bending
    - 5. Assembling the tube
- e. Hydraulic hose
- f. Seal installation
- g. Reservoir installation
- h. Filter installation
- i. Cooler and heat exchange installation
- j. Actuator installation

TASK

MFP-35 Selecting hydraulic fluids

PERFORMANCE OBJECTIVE

Select hydraulic fluids.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Hydraulic fluid selection criteria
    1. Lubricating properties
    2. Viscosity and viscosity index
    3. Resistance to chemical and physical changes
    4. Low temperature properties
    5. Demulsibility
    6. Anti-rust properties
    7. Fire-resistance
    8. Compatibility
    9. General properties
b. Selection of fluid
c. Filling the system
d. Filter installation

Provide Demonstration On:

Filling a system with fluid

Provide Practical Application On:

Selecting hydraulic fluid, filling the system and installing a new filter

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Pippenger and Hicks, Industrial Hydraulics
c. Morrow, Maintenance Engineering Handbook

Student Manuals:

Plant Engineering Training Systems, Hydraulic Troubleshooting, Lesson Five

Tools and Equipment:

a. Hydraulic fluid
b. Filter
c. Tools

LAB HOURS 5

CLASS HOURS 1

EVALUATION (MFP-35)

Given a hydraulic system, the student will select the appropriate fluid, fill the system to the correct level and change the filter. All completed tasks must comply with the instructor's specifications.

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TASK

MFP-36 Planning system maintenance

PERFORMANCE OBJECTIVE

Plan the maintenance of a hydraulic system.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Classifying maintenance
   1. Service
   2. Inspection
   3. Repair
   4. Reconditioning
   5. Testing
b. Inspection
c. Organizing the maintenance
   1. Identifying each system
   2. Keeping a file for maintenance records
d. Maintenance requirements
e. Regular inspections
f. Reservoir fluid level
g. Reservoir fluid temperature
h. External leaks

(Continued on back)

Provide Practical Application On:

Developing a maintenance plan for a hydraulic system

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Pippenger and Hicks, Industrial Hydraulics

Student Manuals:

Plant Engineering Training Systems, Hydraulic Troubleshooting, Lesson Six

LAB HOURS 5

CLASS HOURS 1

EVALUATION (MFP-36)

Given a hydraulic system, the student will plan a maintenance schedule which includes inspection, servicing and overhauling. The system must meet the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

i. External condition of system
j. Operating pressure
k. Fluid quality
l. Filters
m. Machine performance
n. Repair planning
o. Reconditioning planning
p. System servicing

TASK

MFP-37 Troubleshooting hydraulic systems (diagnostic technique)

PERFORMANCE OBJECTIVE

Troubleshoot a hydraulic system and diagnose the problem.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Defining troubleshooting
   1. Diagnosis and symptoms
   2. Evaluating maintenance history
   3. Evaluating symptoms
   4. Determining the cause
   5. Identifying the solution
b. Tools and gages
   1. Wrenches
   2. Gages
c. Applying troubleshooting procedures

Provide Practical Application On:

Troubleshooting a hydraulic system

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Pippenger and Hicks, Industrial Hydraulics

Student Manuals:

Plant Engineering Training Systems, Hydraulic Troubleshooting, Lesson Seven

Tools and Equipment:

a. Tools
b. Gages
c. Maintenance history records

LAB HOURS	5
CLASS HOURS	1

EVALUATION (MFP-37)

Given a defective hydraulic system and appropriate tools, gages and maintenance records, the student will troubleshoot the system and correctly diagnose the problem according to the instructor's specifications.

TASK

MFP-38 Troubleshooting valves

PERFORMANCE OBJECTIVE

Troubleshoot valves on a hydraulic system.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Valve problems
   1. Excessive leakage
   2. Sticking or jamming
   3. Bad controller element
   4. Cracked or broken parts
   5. Distorted or broken springs

b. Valve test procedures

(Continued on back)

Provide Practical Application On:

Troubleshooting and repairing a faulty valve

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Pippenger and Hicks, Industrial Hydraulics

Student Manuals:

Plant Engineering Training Systems, Hydraulic Troubleshooting, Lesson Eight

Tools and Equipment:

a. Valves
b. Tools
c. Parts
d. Gages

LAB HOURS	5
CLASS HOURS	1

EVALUATION (MFP-38)

Given a valve with a defect and appropriate tools, gages and parts, the student will troubleshoot and repair the valve according to the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

c. Repair procedure
    1. Disassembly
    2. Cleaning
    3. Inspection
    4. Repair or replace
    5. Reassembly
    6. Setting to specifications
    7. Testing

d. Solenoid problems
    1. Melted insulation
    2. Physical destruction

TASK

MFP-39 Troubleshooting cylinders

PERFORMANCE OBJECTIVE

Troubleshoot cylinders on a hydraulic system.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Description of cylinders
b. Troubleshooting a cylinder
c. Cylinder testing
d. Cylinder repair
e. Shock absorbers
f. Safety

Provide Practical Application On:

Troubleshooting and repairing a cylinder

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power
b. Pippenger and Hicks, Industrial Hydraulics

Student Manuals:

Plant Engineering Training Systems, Hydraulic Troubleshooting, Lesson Nine

Tools and Equipment:

a. Cylinders
b. Tools and gages

LAB HOURS	5
CLASS HOURS	1

EVALUATION (MFP-39)

Given a defective cylinder and appropriate tools and gages, the student will troubleshoot the cylinder, repair the problem and reinstall the cylinder according to the instructor's specifications.

TASK

MFP-40 Troubleshooting pumps and motors

PERFORMANCE OBJECTIVE

Troubleshoot pumps and motors.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Pumps and motors
   1. Gear
   2. Vane
   3. Axial
   4. Radial

b. Troubleshooting test for
   1. Pressure
   2. Flow
   3. Temperature

c. Gear pump problems
   1. Contamination
   2. Proper fluid conditions
   3. Cavitation
   4. Bearing and shaft wear

d. Vane pump problems

(Continued on back)

Provide Practical Application On:

Troubleshooting a hydraulic system for a pump or motor problem and repairing the defective parts

INSTRUCTIONAL MATERIALS

Textbooks:

a. Pease, Basic Fluid Power

b. Pippenger and Hicks, Industrial Hydraulics

Student Manuals:

Plant Engineering Training Systems, Hydraulic Troubleshooting, Lesson Ten

Tools and Equipment:

a. Hydraulic system with a defective pump or motor

b. Tools and gages

LAB HOURS	5
CLASS HOURS	1

EVALUATION (MFP-40)

Given a hydraulic system with a defective pump or motor and appropriate tools and gages, the student will troubleshoot and repair the defective component according to the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

e. Vane motors
f. Axial piston pump problems
g. Radial piston pump problems
h. Pump and motor repair
i. Pump maintenance checks

TASK

MFP-41 Identifying basic packaging methods

PERFORMANCE OBJECTIVE

Identify basic methods of packaging.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. What is packaging?
    1. Packaging machinery
    2. Containers
b. Packaging operations
    1. Basic operating principles
    2. Skin packing
    3. Blister packing
    4. Shrink packing
c. Filling units
    1. Auger
    2. Weighing
    3. Volumetric and dump fillers
    4. Weighing units
    5. Liquid fillers
d. Maintenance of packaging machinery
e. Panned maintenance
    1. Chain drives
    2. Sprockets
    3. V-belts
    4. Cams
    5. Actuating devices
6. Clutches
7. Bearings
f. Lubrication

INSTRUCTIONAL MATERIALS

Textbooks:

Kazanas, Manufacturing Processes

Student Manuals:

Plant Engineering Training Systems, Introduction to Packaging, Lesson One

LAB HOURS 3

CLASS HOURS 1

EVALUATION (MFP-41)

Given specifications for a packaging operation, the student will identify the type and method of packaging and how to maintain the related machinery.

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TASK

MFP-42 Identifying actuating mechanisms

PERFORMANCE OBJECTIVE

Identify actuating mechanisms.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

- a. Types of actuating mechanisms
  - 1. Levers
  - 2. Bell crank
- b. Cranks
  - 1. Eccentric
  - 2. Oscillating motion
  - 3. Reciprocating motion
- c. Cams
  - 1. Follower
  - 2. Edge
  - 3. Groove
  - 4. Barrell
  - 5. Face
- d. Intermittent motion mechanisms
  - 1. Ratchet, single, double
  - 2. Partial gear
  - 3. Geneva wheel
  - 4. Indexing cam
- e. Geneva wheels
- f. Reciprocating drives
  - 1. Rack and pinion
  - 2. Stroke multiplier
  - 3. Continuous motion chain
- g. Angle-doubling drives
- h. Toggle links
- i. Debents
  - 1. Fixed
  - 2. Adjustable
  - 3. Notched
  - 4. Positive
- j. Overload protector devices

INSTRUCTIONAL MATERIALS

Textbooks:

Kazanas, Manufacturing Processes

Student Manuals:

Plant Engineering Training Systems, Introduction to Packaging, Lesson Two

LAB HOURS 3

CLASS HOURS 1

EVALUATION (MFP-42)

Given illustrations of a packaging machine, the student will correctly identify actuating mechanisms and their applications.

TASK

MFP-43 Identifying basic troubleshooting principles of packaging machinery

PERFORMANCE OBJECTIVE

Identify basic troubleshooting principles of packaging machinery.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Elements of measurement
   1. Linear
   2. Rotary
   3. Liquid
   4. Volumetric
   5. Weight
   6. Systems
   7. Time

b. Tolerances

c. Types of fits
   1. Clearance fits
   2. Interference fit
   3. Transition fit

d. Types of packaging machines
   1. Continuous motion
   2. Intermittent motion

(Continued on back)

Provide Demonstration On:

Troubleshooting a packaging machine

Provide Practical Application On:

Troubleshooting and repairing a packaging machine

INSTRUCTIONAL MATERIALS

Textbooks:

Kazanas, Manufacturing Processes

Student Manuals:

Plant Engineering Training Systems, Introduction to Packaging, Lesson Three

LAB HOURS 9

CLASS HOURS 1

EVALUATION (MFP-43)

Given a packaging machine with a defect, the student will accurately troubleshoot the machine and identify the procedure for correcting the problem.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

e. Basic machine elements
    1. Timing
    2. Position
    3. Stroke
    4. Alignment
    5. Timing dial
f. Troubleshooting a packaging machine

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TASK

MFP-44 Identifying mechanical drives

PERFORMANCE OBJECTIVE

Identify mechanical drives.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

- a. Drive mechanisms
  - 1. Types
  - 2. Maintenance
  - 3. Safety
- b. Couplings
  - 1. Purpose
  - 2. Construction
  - 3. Types
- c. Belt drives
  - 1. Types of belts
  - 2. Pulleys
- d. Chain drives
  - 1. Chain construction
  - 2. Roller chains
  - 3. Chains used in packaging machines
- e. Speed reducers
  - 1. Concentric
  - 2. Paralleled shaft
  - 3. Right-angle shaft
  - 4. Shaft mounted
- f. Gearing
  - 1. Open gearing
  - 2. Spur gears
  - 3. Double helical gears
  - 4. Herringbone
  - 5. Bevel
  - 6. Worm
  - 7. Rack and pinion

INSTRUCTIONAL MATERIALS

Textbooks:

Kazanas, Manufacturing Processes

Student Manuals:

Plant Engineering Training Systems, Introduction to Packaging, Lesson Four

LAB HOURS	3
CLASS HOURS	1

EVALUATION (MFP-44)

Given a packaging machine, the student will correctly identify the types of drive used and describe its operation.

TASK

MFP-45 Identifying motors and brakes

PERFORMANCE OBJECTIVE

Identify motors and brakes.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Primary drive components
   1. Electric motor
   2. Pneumatic motor
   3. Hydraulic motor
   4. Purpose of brake or clutch
b. AC motors
   1. Induction
   2. Synchronous
c. Fractional horsepower motors
   1. Two stator windings
   2. Split-phase motors
   3. Capacitor-start motor
d. Three phase motors

(Continued on back)

Provide Practical Application On:

Identifying types of motors and brakes

INSTRUCTIONAL MATERIALS

Textbooks:

Kazanas, Manufacturing Processes

Student Manuals:

Plant Engineering Training Systems, Introduction to Packaging, Lesson Five

Tools and Equipment:

Examples of various motors and brakes

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LAB HOURS	8
CLASS HOURS	2

EVALUATION (MFP-45)

Given a packaging machine with a motor and brake application, the student will accurately identify the type of motor and brake, describe its operation and recommend appropriate maintenance procedures.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

e. Motor construction classification
    1. Open
    2. Totally closed
f. Special motors
    1. Step motor
    2. Variable speed motor
    3. Rheostat
    4. Eddy-current drive
    5. Silicon controlled rectifier (SCR)
    6. Variable speed drive
g. Mechanical/electrical speed drive
h. Electric clutches
    1. Purpose
    2. Operation
i. Hydraulic clutches
j. Mechanical clutches
    1. Friction clutches
    2. Torque limiting clutch
l. Friction shoe brakes
    1. Construction
    2. Operation
m. Friction disc brakes
    1. Construction
    2. Operation
n. Maintenance of motors and brakes

TASK

MFP-46 Identifying electrical controls

PERFORMANCE OBJECTIVE

Identify electrical controls.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Type of machine band on electrical controls
    1. Run-on-demand
    2. Continuous run
    3. Intermittent motion
b. Startup sequence
c. Motor starters
    1. Manual type
    2. Electric type
    3. Thermal overload
d. Running sequence
e. Machine control
f. Time delay relays
    1. Pneumatic
    2. Electronic
g. Product control
    1. Solenoid operated valves
    2. Intake safety
    3. Loader safety
h. Adhesive application
    1. Intaglio gluing
    2. Spraying glue
    3. Hot melt glue
    4. Rotary cam operated switch
i. Product detectors
    1. Photoelectric
    2. Proximity
    3. Ultrasonic detector
j. Making wiring diagrams

INSTRUCTIONAL MATERIALS

Textbooks:

Kazanas, Manufacturing Processes

Student Manuals:

Plant Engineering Maintenance Systems, Introduction to Packaging, Lesson Six

Tools and Equipment:

Wiring diagram

LAB HOURS 5

CLASS HOURS 1

EVALUATION (MFP-46)

Given a wiring diagram of a packaging operation, the student will correctly identify all electrical controls and describe their operations.

TASK

MFP-47 Identifying packaging materials

PERFORMANCE OBJECTIVE

Identify packaging materials.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Materials
   1. Flexible films
   2. Rigid films
   3. Chipboard
   4. Cardboard
   5. Glass
   6. Plastics
   7. Metals

b. Films
   1. Extrusion or casting
   2. Polyoleims
   3. Acrylics
   4. Vinyls
   5. Risers
   6. Grain, cross grain, fold

c. Shrink films
   1. Shrink tolerances
   2. Polyethylene
   3. Polypropylene
   4. Polyvinyl chloride
   5. Low-density, medium, high-density

d. Non-shrinkable films

e. Combination films
   1. Polycell
   2. Foil paper
   3. Structured films-supported
   4. Shrink films-non-supported

f. Water-soluble films
   1. Polyvinyl-alcohol (PVA)
   2. Applications

g. Plain and coated papers

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

Kazanas, Manufacturing Processes

Student Manuals:

Plant Engineering Training Systems, Introduction to Packaging, Lesson Seven

LAB HOURS	3
CLASS HOURS	1

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EVALUATION (MFP-47)

Given specifications for a material or substance to be packaged, the student will correctly identify an appropriate packaging material and describe its application.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

h. Chipboard cartons
i. Glass bottles and jars
j. Plastic bottles and jars
    1. Manufacturing
    2. Applications

TASK

MFP-48 Identifying methods of filling containers

PERFORMANCE OBJECTIVE

Identify methods used to fill containers.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. What is filling
b. Flexible packaging
c. Vertical fill machines
d. Horizontal fill machines
e. Pouch filling
f. Weight filling
g. Carton filling
h. Liquid filling
i. Filling by count

INSTRUCTIONAL MATERIALS

Textbooks:

Kazanas, Manufacturing Processes

Student Manuals:

Plant Engineering Training Systems, Introduction to Packaging, Lesson Eight

LAB HOURS	3
CLASS HOURS	1

EVALUATION (MFP-48)

Given specifications for a product to be packaged, the student will correctly identify a method of filling which is appropriate and economical for that product.

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TASK

MFP-49 Identifying methods of sealing

PERFORMANCE OBJECTIVE

Identify methods used to seal packages and choose a method for a given application.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Defining sealing
b. Tube sealing
c. Film sealing
d. High frequency sealing
e. Capping
f. Seaming
g. Tying
h. Sewing
i. Gluing
j. Stapling or stitching
k. Strapping

INSTRUCTIONAL MATERIALS

Textbooks:	Student Manuals:
Kazanas, Manufacturing Processes	Plant Engineering Training Systems, Introduction to Packaging, Lesson Nine

LAB HOURS	3
CLASS HOURS	1

EVALUATION (MFP-49)

Given specifications for a packaging method, the student will accurately identify and describe the appropriate method of sealing the package.

TASK

MFP-50 Identifying the processes used for heat treatment of materials

PERFORMANCE OBJECTIVE

Identify methods used to heat treat metals.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Metallurgy and heat treatment
b. Principles of heat treating
c. Equilibrium diagrams
d. Transformation of temperatures
e. Iron-carbon phase diagram
    1. Liquidous line
    2. Solidous line
    3. Eutectic point
    4. Austenite
    5. Delta ferrite
    6. Alpha ferrite
    7. Eutectoid
    8. Pearlite
f. Effects of heating, holding, cooling
g. Isothermal transformation
    1. S-curve or TTT diagram
    2. Pearlite
    3. Bainite
    4. Martensite
h. Heat treating ferrous metals
    1. Hardening
    2. Tempering
    3. Annealing
    4. Normalizing
    5. Spheroidizing
    6. Casehardening

INSTRUCTIONAL MATERIALS

Textbooks:

a. Feirer, General Metals
b. Harold V. Johnson, Technical Metals

Student Manuals:

Plant Engineering Training Systems, Metal Materials, Lesson Three

LAB HOURS	3
CLASS HOURS	1

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EVALUATION (MFP-50)

Given the name of a specified heat treatment process for metals, the student will identify and describe the process in terms of the properties of the metal.

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TASK

MFP-51 Identifying the processes used to produce plastics

PERFORMANCE OBJECTIVE

Identify plastics.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Nature of plastics
   1. Polymers
   2. Polymerization
   3. Resins
   4. Thermoplastics
   5. Thermosets
   6. Tradenames
b. Processing and fabricating plastics
c. Molding processes
   1. Injection molding
   2. Compression molding
   3. Transfer molding
   4. Blow molding
   5. Thermoforming
   6. Rotational molding
d. Casting and forming processes
   1. Expanded bead molding
   2. Foam molding
e. Extrusion
   1. Blown film extrusion
   2. Wire extrusion coating
f. Reinforced plastics
   1. Calendering
   2. Laminations
   3. Filament winding
g. Machining plastics
   1. Sawing
   2. Drilling
   3. Cutting threads
   4. Grinding, sanding, buffing
   5. Metal inserts

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

a. Schmidt, Basic Plastics
b. Richardson, Modern Industrial Plastics

A/Vs:

Bobbs-Merrill, "Foam Molding," slide tape, "Injection Molding," slide/tape, "Polymer Structure," slide/tape, "Reinforced Plastics," slide/tape, "Rotational Molding," slide/tape and "Thermoforming," slide/tape

Student Manuals:

Plant Engineering Training Systems, Non-metal Materials, Lesson Two

LAB HOURS 3

CLASS HOURS 1

EVALUATION (MFP-51)

Given specifications for a plastic material, the student will identify the type of plastic, the process used to produce it and its applications. The completed task must comply with the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

h. Plastic assembly methods
    1. Processes
    2. Safety
i. Plastic welding
j. Patching with plastic
    1. Polyesters
    2. Epoxus

TASK

MFP-52 Identifying the processes used to produce iron

7

PERFORMANCE OBJECTIVE

Identify processes used to produce iron.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Iron ore
b. Making pig iron
    1. Pigs
    2. Pig molds
    3. Smelting
    4. Reduction
    5. Charging the blast furnace
c. Making cast iron
    1. Categories of iron-carbon alloys
    2. Elements in cast iron
    3. Advantages of cast iron
    4. Cupola
    5. Cementite
d. Gray cast iron
    1. Characteristics
    2. Applications
e. White cast iron
    1. Characteristics
    2. Applications
f. Malleable cast iron
    1. Characteristics
    2. Applications
g. Ductile cast iron
    1. Characteristics
    2. Applications
h. Producing steel from iron
    1. Open-hearth process
    2. Bessemer process
    3. Basic oxygen process
    4. Electric furnace process

INSTRUCTIONAL MATERIALS

Textbooks:

a. Feirer, General Metals
b. Harold V. Johnson, Technical Metals

Student Manuals:

Plant Engineering Training Systems, Metal Materials, Lesson Five

LAB HOURS 3
CLASS HOURS 1

7

EVALUATION (MFP-52)

Given specifications for a type of iron and steel, the student will identify and describe the processes used to produce the iron and steel. The student will identify the characteristics and applications of the metal. The completed tasks must be in accordance with the instructor's specifications.

TASK

MFP-53 Identifying processes used to produce steel

PERFORMANCE OBJECTIVE

Identify processes used to produce steel.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Carbon steels
   1. Points
   2. Low carbon steel
   3. Medium carbon steel
   4. High carbon steel

b. Rolling steel
   1. Ingots
   2. Blooms, billets on slabs

c. Steel forms
   1. Plate
   2. Sheet
   3. Strip
   4. Bars
   5. Hot-rolled
   6. Cold-drawn
   7. Cast

(Continued on back)

Provide Demonstration On:

Identifying steel codes

Provide Practical Application On:

Identifying the type of steel given and its code

INSTRUCTIONAL MATERIALS

Textbooks:

a. Feirer, General Metals

b. Harold V. Johnson, Technical Metals

Student Manuals:

Plant Engineering Training Systems, Metal Materials, Lesson Six

LAB HOURS 3

CLASS HOURS 1

EVALUATION (MFP-53)

Given a piece of steel which is coded, the student will identify the code, describe the process used to produce the steel and identify the application of the steel according to instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

d. Hot-rolled steel sheet
    1. Commercial quality (CQ)
    2. Drawing quality (PQ)
    3. Physical quality (PQ)
e. Cold-rolled steel sheets
f. Hot-rolled carbon steel strips
g. Cold-rolled carbon steel strips
h. Carbon steel plates
i. Carbon steel bars
j. Structural steel
k. Constructional grade and tool steels
l. Stainless steel
    1. Austenitic
    2. Ferritic
    3. Martensitic
m. Alloy steels
n. Steel classification
    1. SAE
    2. AISI
o. Steel color codes

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TASK

MFP-54 Identifying processes used to produce aluminum

PERFORMANCE OBJECTIVE

Identify processes used to produce aluminum.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

- a. Properties of aluminum
  - 1. Low density
  - 2. High strength
  - 3. Electrical conductor (EC) grade
  - 4. Easy to fabricate
  - 5. Non-magnetic and non-sparking
- b. Production of aluminum
- c. Aluminum based alloys
  - 1. Wrought grades
  - 2. Casting grades
- d. Wrought aluminum grades
  - 1. Aluminum association designation system
  - 2. Temper designation
- e. Aluminum casting grades
  - 1. Aluminum association system
  - 2. Codes for heat-treatable casting alloys
- f. Alloying elements
  - 1. Copper
  - 2. Silicon
  - 3. Magnesium
  - 4. Non-impurities
  - 5. Zinc, nickel and tin
- g. Forming processes
  - 1. Forging
  - 2. Powder metallurgy
  - 3. Cladding

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

- a. Feirer, General Metals
- b. Harold V. Johnson, Technical Metals

Student Manuals:

Plant Engineering Training Systems, Metal Materials, Lesson Seven

Tools and Equipment:

- a. Torch
- b. Aluminum
- c. Solder
- d. Flux
- e. Steel wool or emery cloth
- f. Solvent

LAB HOURS 3

CLASS HOURS 1

EVALUATION (MFP-54)

Given a section of aluminum, the student will identify the type and describe the process used to produce it. Using this section of aluminum, the student will solder a joint. The completed task must meet the instructor's requirements.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

h. Anodizing
    1. Purpose
    2. Industrial applications

i. Joining aluminum
    1. Welding
    2. Brazing
    3. Soldering
    4. Soldering safety

TASK

MFP-55 Identifying processes for the production of magnesium and titanium

PERFORMANCE OBJECTIVE

Identify the processes for the production of magnesium and titanium.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Production of magnesium
    1. Magnesium fluoride
    2. Magnesite
    3. Dolomite
    4. Carnallite
b. Extraction of magnesium
    1. Electrolytic method
    2. Carbothermic method
c. Alloying melting and refining magnesium
    1. Process
    2. Equipment
d. Alloying magnesium
e. Magnesium alloy designations
f. Magnesium casting alloys
    1. Magnesium-aluminum-manganese (AM)
    2. Magnesium-aluminum-zinc (AZ)
    3. Magnesium-rare earth-zirconium (EK, EZ and ZE)
    4. Magnesium-zinc-zirconium (ZK)
    5. Magnesium-thorium-zirconium (HK, HZ and ZH)
g. Magnesium wrought alloys
h. Extrusion

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

a. Feirer, General Metals
b. Harold V. Johnson, Technical Metals

Student Manuals:

Plant Engineering Training Systems, Metal Materials, Lesson Eight

LAB HOURS	3
CLASS HOURS	1

EVALUATION (MFP-55)

Given a specification for magnesium, titanium or an alloy, the student will identify the metal, describe the process used to refine it and identify procedures used to join the metal. The completed task must meet the instructor's specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

i. Rolling
j. Forming
k. Machining
l. Magnesium fires and safety
m. Joining magnesium
    1. Welds, rivets, bolts or screws
    2. TIG welding and MIG welding
n. Titanium
    1. Processing
    2. Commercially pure titanium
    3. Uses of titanium

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TASK

MFP-56 Identifying processes used to produce copper

PERFORMANCE OBJECTIVE

Identify processes used to produce copper.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

- a. Producing copper
    - 1. Ores
    - 2. Separating ore
    - 3. Blister copper
    - 4. Anodes
    - 5. Cathodes
- b. Copper alloys
    - 1. Silver
    - 2. Boron
    - 3. Lithium
- c. Machinability ratings
    - 1. Adding lead
    - 2. Naval brass
    - 3. Red brass
- d. Electrical conductivity
- e. Corrosion resistance
- f. Annealing copper
- g. Brass
    - 1. Yellow (cartridge) brass
    - 2. Muntz metal
    - 3. Admiralty brass
    - 4. Bronze
- h. Phosphor bronze alloy
- i. Nickel silver
- j. Aluminum bronze
- k. Other bronzes
    - 1. Manganese
    - 2. Silicon
    - 3. Bull bronze
    - 4. Nickel bronze
- l. Beryllium copper
- m. Cupro-nickel
- n. Copper-alloy casting

INSTRUCTIONAL MATERIALS

Textbooks:

- a. Feirer, General Metals
- b. Harold V. Johnson, Technical Metals

Student Manuals:

Plant Engineering Training Systems, Metal Materials, Lesson Nine

LAB HOURS 3

CLASS HOURS 1

EVALUATION (MFP-56)

Given specifications for copper, the student will identify the type of copper or alloy and describe the process used to produce the metal according to the instructor's specifications.

TASK

MFP-57 Identifying processes used to produce lead, nickel, tin and zinc

PERFORMANCE OBJECTIVE

Identify processes used to produce lead, nickel, tin and zinc.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Properties of lead
    1. Corrosion resistance
    2. Dense
    3. Soft
    4. Low melting point
    5. Color
b. Production of lead
c. Available forms of lead
    1. Pig
    2. Ingot
    3. Piping and tubing
d. Forming and fabricating lead
e. Methods of joining lead
    1. Soldering
    2. Welding (burning)
f. Producing nickel
    1. Uses of nickel
    2. Alloys
g. Properties of tin
    1. Brightness
    2. Corrosion resistance
    3. Low melting point
    4. Malleable
    5. Other properties
h. Uses of tin in industry
i. Tin plate
j. Tin alloys
k. Solders
l. Babbitt
m. Bronze
n. Zinc
    1. Producing zinc
    2. Zinc coatings
    3. Zinc paints
    4. Zinc compounds
    5. Machining zinc

INSTRUCTIONAL MATERIALS

Textbooks:

a. Feirer, General Metals
b. Harold V. Johnson, Technical Metals

Student Manuals:

Plant Engineering Training Systems, Metal Materials, Lesson Ten

LAB HOURS 3
CLASS HOURS 1

EVALUATION (MFP-57)

Given specifications for lead, nickel, tin and zinc, the student will identify the processes used to produce the metals and describe their properties and applications.

TASK

MFP-58 Identifying common couplings

PERFORMANCE OBJECTIVE

Identify common couplings.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Couplings
b. Coupling requirements
    1. Coupling two rotating shafts
    2. Compensating for shaft misalignment
    3. Allowing axial or end movement of the coupled shafts
    4. Dampening vibrations
    5. Dampen-absorbing torque
    6. Electrical installation

(Continued on back)

Provide Practical Application On:

Identifying types of couplings and describing their operation and applications

INSTRUCTIONAL MATERIALS

Textbooks:

Delmar, Electromechanical Technology Series, Drives

Student Manuals:

Plant Engineering Training Systems, Drive Components, Lesson One

Tools and Equipment:

Examples of several types of couplings

LAB HOURS	3
CLASS HOURS	1

EVALUATION (MFP-58)

Given examples of couplings, the student will correctly identify the couplings and describe their operations and applications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

c. Types of misalignment
    1. Parallel
    2. Angular
    3. Combined parallel and angular
d. Solid couplings
    1. Flanged type
    2. Ribbed
    3. Universal joint
    4. Installing a flanged coupling
e. Jaw couplings
    1. Metal-to-metal contact
    2. Flexible coupling
f. Molded rubber couplings
g. Chain type couplings
h. Gear type couplings
i. Metal disc couplings

TASK

MFP-59 Identifying clutches

PERFORMANCE OBJECTIVE

Identify clutches.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Comparing clutches and couplings
b. Classes of clutches
    1. Mechanical
    2. Electrical
    3. Hydraulic
c. Jaw clutches
    1. Slow speed applications
    2. Shifting arm
d. Friction clutches
e. Tooth type mechanical clutches
f. Friction type centrifugal clutches
g. Over-running or one way clutches
h. Electric clutches
i. Fluid clutches

Provide Practical Application On:

Determining the type of clutch needed for a given application

INSTRUCTIONAL MATERIALS

Textbooks:

Delmar, Electromechanical Technology Series, Drives

Student Manuals:

Plant Engineering Training Systems, Clutches, Lesson Three

LAB HOURS	3
CLASS HOURS	1

EVALUATION (MFP-59)

Given specifications for an application which requires a clutch, the student will identify and describe a clutch. The completed task must meet the instructor's requirements.

TASK

ITI-01 Identifying and using basic measuring instruments

PERFORMANCE OBJECTIVE

Identify and use basic measuring tools.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Classifying measuring tools
   1. Linear measurement
   2. Angular measurement
   3. Transferring measurements

b. Rules and tapes
   1. Steel rule
   2. Folding rulers and tapes
   3. Taking measurements

c. Calipers
   1. Inside diameter
   2. Outside diameter
   3. Slide diameter

d. Micrometers

e. Squares

Provide Demonstration On:

Procedures for using a micrometer

Provide Practical Application On:

Using the following tools to make measurements
1. Calipers
2. Micrometers

INSTRUCTIONAL MATERIALS

Textbooks:

a. Dover Publications, Tools and Their Uses

b. Hinrichs, Measuring

A/Vs:

a. Hobar, "Micrometers, Calipers and Gages," transparencies and "Reading the Micrometers," transparencies

b. DCA Educational Products, "Precision Measurement," transparencies

Student Manuals:

Plant Engineering Training Systems, Hand Tools, Lesson One

Tools and Equipment:

a. Several types of calipers

b. Several types of micrometers

c. Items to measure

LAB HOURS 3

CLASS HOURS 1

EVALUATION (ITI-01)

Given a measuring tool and an assigned measurement, the student will accurately use the tool and make the measurement. The measurement must be in compliance with the industry's standards.

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TASK

ITI-02 Identifying and using volt-ohm milliammeters (VOM)

PERFORMANCE OBJECTIVE

Identify and use volt-ohm milliammeters.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. VOM safety
b. VOM control settings
c. VOM scale interpretation

Provide Demonstration On:

a. Safe use of a VOM
b. How to correctly connect and read the VOM in measuring voltage, current and resistance

Provide Practical Application On:

a. Identifying VOM safety rules
b. Setting VOM controls for voltage, current and resistance measurements
c. Measuring and reading assigned voltage, current and resistance

INSTRUCTIONAL MATERIALS

Textbooks:

a. Grob, Basic Electronics
b. Gilli, Electrical Principles for Electronics

A/Vs:

Georgia, Electronics Technology, Phase A, "Use and Care of the VOM and VTVM," slide/tape 14-A

Student Manuals:

a. Heathkit, DC Electronics, Student Workbook
b. Georgia, Electronics Technology, Phase A, Unit 14
c. MAVCC, Basic Electronics 1

Tools and Equipment:

a. VOM
b. Circuit to provide voltage, current and resistance measurements

LAB HOURS	5
CLASS HOURS	1

EVALUATION (ITI-02)

a. Given a VOM and an assigned circuit, the student will correctly set and connect the VOM to the circuit and make accurate measurements of current and resistance voltage.

b. Heathkit, DC Electronics, Student Workbook.

c. MAVCC, Basic Electronics 1.

d. Georgia, Electronics Technology, Phase A, Student Tests.

TASK

ITI-03 Identifying and using electronic voltmeters (EVM)

PERFORMANCE OBJECTIVE

Identify and use the operating controls on the EVM.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. EVM safety
b. EVM control functions
c. EVM interpretation

Provide Demonstration On:

a. EVM safety
b. Connecting and reading an EVM to measure current and resistance voltage

Provide Practical Application On:

a. Listing EVM safety rules/procedures
b. Setting up and reading current and resistance voltage using the EVM

INSTRUCTIONAL MATERIALS

Textbooks:

a. Grob, *Basic Electronics*
b. Gilli, *Electrical Principles for Electronics*

A/Vs:

Georgia, Electronics Technology, Phase A, "Use and Care of the VOM and VTVM," slide/tape 14-A

Tools and Equipment:

a. EVM
b. Circuit to provide voltage, current and resistance measurements

LAB HOURS 5
CLASS HOURS 1

EVALUATION (ITI-03)

a. Given an EVM and an assigned circuit, the student will correctly set up the controls and accurately measure current and resistance voltage.

b. Heathkit, DC Electronics, Student Workbook.

c. MAVCC, Basic Electronics 1.

d. Georgia, Electronics Technology, Phase A, Student Tests.

TASK

ITI-04 Identifying and using ohmmeters

PERFORMANCE OBJECTIVE

Identify and use ohmmeters.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Ohmmeter safety
b. Ohmmeter control setting
c. Ohmmeter scale reading
d. Color code
e. Resistance tolerance

Provide Demonstration On:

a. Ohmmeter safety
b. Connecting and reading the ohmmeter
c. Calculating resistance tolerance limits for good/bad

Provide Practical Application On:

a. Listing/demonstrating ohmmeter safety
b. Setting up ohmmeter and connecting to resistors

INSTRUCTIONAL MATERIALS

Textbooks:

a. Grob, Basic Electronics
b. Gilli, Electrical Principles for Electronics

A/Vs:

Georgia, Electronics Technology, Phase A, "Resistor Color Code and Use of the Ohmmeter," slide/tape 8-A

Student Manuals:

a. Heathkit, DC Electronics, Student Workbook
b. Georgia, Electronics Technology, Phase A, Unit 8-A
c. MAVCC, Basic Electronics I

Tools and Equipment:

a. ET-3100 Electronic Design Experimeter or equivalent
b. Voltmeter with test leads
c. Resistors (good and bad)

LAB HOURS 5

CLASS HOURS 1

EVALUATION (ITI-04)

a. Given an ohmmeter and resistors of unknown value, the student will determine the value of each resistor. Readings must be within instructor's specifications.

b. Heathkit, DC Electronics, Student Workbook.

c. MAVCC, Basic Electronics 1.

d. Georgia, Electronics Technology, Phase A, Student Tests.

TASK

ITI-05 Identifying and using oscilloscopes

PERFORMANCE OBJECTIVE

Identify and use oscilloscopes.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. O-scope safety
b. O-scope preliminary control settings
c. O-scope hook-up to circuit
d. Scale interpretation

Provide Demonstration On:

a. How to use the scope manual to set up vertical and horizontal controls
b. How to correctly connect and read the voltage P-P, frequency and period of an AC signal

Provide Practical Application On:

Measuring voltage, current period, frequency and time intervals

INSTRUCTIONAL MATERIALS

Textbooks:

a. Zbar, Basic Electricity
b. Gilmore, Instruments and Measurements

A/Vs:

a. Georgia, Electronics Technology, Phase A, "Function and Use of the Oscilloscope," slide/tape 28-A
b. Bergwall, "Basic Electricity and Electronics Explained-AC," filmstrips

Student Manuals:

a. Heathkit, Electronic Circuits, Student Workbook
b. Georgia, Electronics Technology, Phase A, Unit 28-A
c. MAVCC, Basic Electronics I

Tools and Equipment:

a. Oscilloscope
b. Manual for scope
c. Circuit to provide voltage, current and AC signals to be measured

LAB HOURS 5

CLASS HOURS 1

EVALUATION (ITI-05)

a. Given an oscilloscope and necessary circuits, the student will measure and record the peak to peak amplitude, period and frequency of signals. Recordings must be within ten percent of known values.

b. Heathkit, AC Electronics, Student Workbook.

c. MAVCC, Basic Electronics 1.

d. Georgia, Electronics Technology, Phase A, Student Tests.

e. Bergwall, filmstrip study questions.

TASK

ITI-06 Identifying and using tube testers

PERFORMANCE OBJECTIVE

Identify and use tube testers.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Tube tester safety
b. Preliminary control settings (how to use the set up chart)
c. How to interpret the meter scale

Provide Demonstration On:

a. How to set up the tube tester by the tube chart
b. How to insert the tube
c. How to test the tube
d. How to read the scale for good/bad decision

Provide Practical Application On:

Testing tubes for condition with tube tester

INSTRUCTIONAL MATERIALS

Student Manuals:

Georgia, Electronics, Phase B, Unit 13-B

Tools and Equipment:

a. Tube tester
b. Manual
c. Good and bad tubes

LAB HOURS	5
CLASS HOURS	1

EVALUATION (ITI-06)

Given a tube tester and necessary tools and equipment, the student will test a selection of tubes and record the condition. Recordings must be accurate within known values.

TASK

ITI-07 Identifying and using transistor analyzers

PERFORMANCE OBJECTIVE

Identify and use transistor analyzers.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Transistor analyzer safety
b. Preliminary control settings (how to use the set up chart)
c. How to hook-up the test leads
d. How to interpret the meter readings

Provide Demonstration On:

a. How to set up the transistor analyzer controls by the analyzer chart
b. How to safely hook-up the test leads
c. How to read the meter values

INSTRUCTIONAL MATERIALS

Student Manuals:

a. Georgia, Electronics, Phase B, Unit 6-B
b. Heathkit, Solid State Electronics, Student Workbook

Tools and Equipment:

a. Transistor analyzer
b. Manual
c. Good and bad transistors

LAB HOURS	5
CLASS HOURS	1

EVALUATION (ITI-07)

a. Given a transistor analyzer and a selection of transistors, the student will determine the condition of the transistors to 100% accuracy.

b. Heathkit, Solid State Electronics, Student Workbook.

TASK

ITI-08 Identifying and using capacitor testers

PERFORMANCE OBJECTIVE

Identify and use capacitor testers.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Capacitor tester safety
b. Capacitor tester hook-up to circuit or part
c. Capacitor tester preliminary control settings
d. Scale interpretation

Provide Demonstration On:

a. How to use the capacitor tester manual to correctly pre-set operation controls
b. How to correctly connect and read the capacitor tester scale to determine leakage and capacitance values

Provide Practical Application On:

Demonstrating the correct and safe way to set up, connect and read the results of using a capacitor tester to check capacitor parameters

INSTRUCTIONAL MATERIALS

Student Manuals:

a. Heathkit, DC Electronics, Student Workbook
b. Georgia, Electronics Technology, Phase A, Units 31-A and 32-A
c. MAVCC, Basic Electronics 1

Tools and Equipment:

a. Capacitor tester manual
b. Capacitor tester
c. Capacitors to be checked
d. Capacitor specification manual

LAB HOURS	5
CLASS HOURS	1

EVALUATION (ITI-08)

a. Given a capacitor tester and ten capacitors of unknown condition, the student will demonstrate to the instructor the safe way to connect, set up, read and record the results of the measurements. The student must correctly identify the servicable and defective capacitors.

b. Heathkit, DC Electronics, Student Workbook.

c. MAVCC, Basic Electronics 1.

d. Georgia, Electronics Technology, Phase A, Student Tests.

TASK

ITI-09 Identifying and using sine wave generators

PERFORMANCE OBJECTIVE

Identify and use sine wave generators.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Generator safety
b. Generator control settings
c. Generator hook-up to test circuit

Provide Demonstration On:

a. How to use the sine wave generator manual to set up the controls
b. How to correctly connect to a test circuit

Provide Practical Application On:

Setting up and connecting the sine wave generator to a test circuit

INSTRUCTIONAL MATERIALS

Textbooks:

Grob, Basic Electronics

A/Vs:

Georgia, Electronics Technology, Phase A, "AC Current and Voltage," slide/tape 26-A

Student Manuals:

a. Heathkit, Electronic Circuits, Student Workbook
b. Georgia, Electronics Technology, Phase A, Unit 26-A
c. MAVCC, Basic Electronics 1

Tools and Equipment:

a. Manual
b. Sine wave generator
c. Test circuit

LAB HOURS	5
CLASS HOURS	1

EVALUATION (ITI-09)

a. Given a sine wave generator and a test circuit with required signal specifications, the student will set up the controls to the proper values and connect the generator to the test circuit.

b. Heathkit, AC Electronics, Student Workbook.

c. MAVCC, Basic Electronics 1.

d. Georgia, Electronics Technology, Phase A, Student Tests.

e. V'TECS, Electronics Mechanics, Task No. A-01.

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TASK

ITI-09 Identifying and using sine wave generators

PERFORMANCE OBJECTIVE

Identify and use sine wave generators.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Generator safety
b. Generator control settings
c. Generator hook-up to test circuit

Provide Demonstration On:

a. How to use the sine wave generator manual to set up the controls
b. How to correctly connect to a test circuit

Provide Practical Application On:

Setting up and connecting the sine wave generator to a test circuit

INSTRUCTIONAL MATERIALS

Textbooks:

Grob, Basic Electronics

A/Vs:

Georgia, Electronics Technology, Phase A, "AC Current and Voltage," slide/tape 26-A

Student Manuals:

a. Heathkit, Electronic Circuits, Student Workbook
b. Georgia, Electronics Technology, Phase A, Unit 26-A
c. MAVCC, Basic Electronics 1

Tools and Equipment:

a. Manual
b. Sine wave generator
c. Test circuit

LAB HOURS	5
CLASS HOURS	1

EVALUATION (ITI-09)

a. Given a sine wave generator and a test circuit with required signal specifications, the student will set up the controls to the proper values and connect the generator to the test circuit.

b. Heathkit, AC Electronics, Student Workbook.

c. MAVCC, Basic Electronics 1.

d. Georgia, Electronics Technology, Phase A, Student Tests.

e. V'TECS, Electronics Mechanics, Task No. A-01.

TASK

ITI-10 Identifying and using signal generators

PERFORMANCE OBJECTIVE

Identify and use signal generators.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Signal generator safety
b. Signal generator control settings
c. Signal generator hook-up to test circuit

Provide Demonstration On:

a. How to use the signal generator manual to set up the operator controls
b. How to correctly connect the signal generator to a test circuit

Provide Practical Application On:

Demonstrating skills and knowledge of the correct and safe way to set up and connect the signal generator to a test circuit

INSTRUCTIONAL MATERIALS

Textbooks:

Grob, Basic Electronics

Student Manuals:

Georgia, Electronics, Phase C, Unit 3-C

Tools and Equipment:

a. Manual
b. Basic signal generator
c. Test circuit

LAB HOURS 5
CLASS HOURS 1

EVALUATION (ITI-10)

Given a signal generator manual and test circuit with required signal specifications, the student will set up the controls to the proper values and connect the generator to the test circuit.

TASK

ITI-11 Identifying and using pulse generators

PERFORMANCE OBJECTIVE

Identify and use pulse generators.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Generator safety
b. Generator control settings
c. Generator hook-up procedures

Provide Demonstration On:

a. How to use the pulse generator manual for a required signal output
b. How to connect the pulse generator to a test circuit

Provide Practical Application On:

Setting up and connecting the pulse generator to a test circuit

INSTRUCTIONAL MATERIALS

Textbooks:

Grob, Basic Electronics

Student Manuals:

a. Heathkit, AC Electronics, Student Workbook
b. MAVCC, Basic Electronics 1

Tools and Equipment:

a. Manual
b. Pulse generator
c. Test circuit

LAB HOURS 5

CLASS HOURS 1

EVALUATION (ITI-11)

Given a pulse generator, manual and test circuit with required signal parameters, the student will demonstrate to the instructor the correct way to set up the controls and how to hook-up the generator to the test circuit.

TASK

ITI-12 Identifying and using square wave generators

PERFORMANCE OBJECTIVE

Identify and use square wave generators.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Generator safety
b. Generator control settings and adjustments
c. Generator hook-up procedures
d. Generator testing procedures

Provide Demonstration On:

a. How to use the square wave generator manual to set up a required output signal
b. How to correctly connect the square wave generator to a test circuit

Provide Practical Application On:

Setting up and connecting the signal generator to a test circuit

INSTRUCTIONAL MATERIALS

Textbooks:

Grob, Basic Electronics

Student Manuals:

a. Heathkit, DC Electronics, Student Workbook
b. MAVCC, Basic Electronics 1

Tools and Equipment:

a. Manual
b. Square wave generator
c. Test circuit with specifications

LAB HOURS	5
CLASS HOURS	1

EVALUATION (ITI-12)

a. Given a square wave generator, manual and test circuit with required signal parameters, the student will demonstrate to the instructor how to set the controls of the square wave generator for the required output and how to connect the generator to the test circuit.

b. Heathkit, AC Electronics, Student Workbook.

c. MAVCC, Basic Electronics 1.

TASK

ITI-13 Identifying and using impedance testers

PERFORMANCE OBJECTIVE

Identify and use impedance testers.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Safety
b. Impedance tester control settings
c. Impedance tester hook-up procedures
d. Impedance tester readings

Provide Demonstration On:

a. How to use the impedance manual to set up the test controls
b. How to correctly connect the impedance tester for circuit measurements
c. How to interpret meter readings

Provide Practical Application On:

Hooking up and setting up operator controls and reading the impedance tester meter readings

INSTRUCTIONAL MATERIALS

Student Manuals:

a. Heathkit, AC Electronics, Student Workbook
b. MAVCC, Basic Electronics 1

Tools and Equipment:

a. Manual
b. Impedance tester
c. Test circuit

LAB HOURS 5

CLASS HOURS 1

EVALUATION (ITI-13)

Given an impedance tester, manual and test circuit with reactive components, the student will set up and measure unknown impedance values. All readings must be within five percent of actual values.

TASK

ITI-14 Identifying and using frequency meters

PERFORMANCE OBJECTIVE

Identify and use frequency meters.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Equipment safety
b. Equipment control settings
c. Equipment hook-up procedures

Provide Demonstration On:

a. How to use the frequency manual to adjust controls for testing
b. How to correctly connect and measure the frequency of a test circuit

Provide Practical Application On:

Using the frequency meter to test a circuit

INSTRUCTIONAL MATERIALS

Textbooks:

Grob, Basic Electronics

Student Manuals:

a. Heathkit, AC Electronics, Student Workbook
b. MAVCC, Basic Electronics 1

Tools and Equipment:

a. Manual
b. Frequency meter
c. Test circuit to be measured

LAB HOURS 5

CLASS HOURS 1

EVALUATION (ITI-14)

Given a frequency meter, manual and test circuit, the student will use the meter to make a frequency measurement. Readings must be within five percent of known frequencies.

TASK

ITI-15 Using test instruments to measure voltage, current and resistance

PERFORMANCE OBJECTIVE

Demonstrate a knowledge of meter movement and how it is used to measure current, voltage and resistance.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. VOM meter movement
   1. Construction
   2. Operation
   3. Taut-band movement
b. The ammeter
   1. Increasing the range
   2. Computing shunt resistance
   3. Accuracy
c. The voltmeter
   1. Extending the range
   2. Calculating the multiplier
   3. Multiple-range voltmeters
   4. Sensitivity
   5. Loading effect

(Continued on back)

Provide Demonstration On:

a. Determining the sensitivity of a voltmeter
b. Loading effects of the voltmeter
c. Extending the current range of meters

INSTRUCTIONAL MATERIALS

Textbooks:

a. Georgia, Electronics Technology, Phase A
b. Grob, Basic Electronics
c. Heathkit, DC Electronics
d. MAVCC, Basic Electronics 1

A/Vs:

(Continued on back)

Student Manuals:

a. Georgia, Electronics Technology, Phase A, Units 14-A and 22-A
b. Heathkit, DC Electronics
c. Meade, Programmed Projects

Tools and Equipment:

(Continued on back)

LAB HOURS	5
CLASS HOURS	1

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EVALUATION (ITI-15)

a. Given the tools and equipment listed for this unit, the student will demonstrate the proper use and care of electrical test instruments, including the use of the Ayrton Shunt to extend the current range of meters.

b. Test and review questions can be found in:
   1. Grob, Basic Electronics.
   2. Meade, Programmed Projects.
   3. Georgia, Electronics Technology, Phase A, Units 14-A and 22-A.
   4. Heathkit, DC Electronics.
   5. MAVCC, Basic Electronics 1.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

d. The ohmmeter
   1. Scale calibration
   2. Creating higher and lower ranges
   3. The shunt ohmmeter

e. Multimeters
   1. Electronic multimeters
   2. Inaccuracies in measuring

INSTRUCTIONAL MATERIALS

A/Vs:

a. Georgia, Electronics Technology, Phase A, "Proper Use and Care of Meters," slide/tape 14-A
b. Georgia, Electronics Technology, Phase A, "The Ayrton or Universal Meter Shunt," slide/tape 22-A

Tools and Equipment:

a. VOM
b. VTVM
c. Basic electricity/electronics trainer
d. Variable voltage DC power supply
e. Variable voltage AC power supply
f. 10M ohm, ½-watt, 10% resistor
g. 100K ohm potentiometer
h. 100 ohm, ½-watt, 1% resistor
i. 220K ohm, ½-watt, 5% resistor
j. 1M ohm, ½-watt, 5% resistor
k. 10M ohm, ½-watt, 10% resistor
l. 1K ohm potentiometer

TASK

ITI-16 Calculating values in DC network circuits

PERFORMANCE OBJECTIVE

Calculate values in DC network circuits.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Simple circuits
b. Voltage dividers
c. Bridge circuits
    1. Balance bridge
    2. Unbalanced bridge
    3. Applications of the bridge circuit
d. Kirchoff's law
    1. Kirchoff's voltage law
    2. Kirchoff's current law
e. Superposition theorem
f. Thevenin's theorem
g. Norton's theorem
h. Maximum power transfer theorem

Provide Practical Application On:

a. Bridge circuits
b. Maximum power transfer theorem
c. Series voltage dividers
d. Parallel current dividers

INSTRUCTIONAL MATERIALS

Textbooks:

a. Grob, Basic Electronics
b. Georgia, Electronics Technology, Phase A
c. Heathkit, DC Electronics
d. MAVCC, Basic Electronics 1

Student Manuals:

(Continued on back)

Tools and Equipment:

a. ET-3100 Electronic Design Experimeter or equivalent
b. Volt-ohm-meter with test leads
c. 470 ohm ½-watt 5% resistor
d. 68 ohm ½-watt 5% resistor
e. 1000 ohm ½-watt 1% resistor
f. 1000 ohm ½-watt 5% resistor

(Continued on back)

LAB HOURS ☐

CLASS HOURS ☐

EVALUATION (ITI-16)

a. Given the tools and equipment listed for this unit, the student will diagram, construct and test the following circuits:
   1. A three resistor series voltage divider in which $E_{R1} = E_{R3}$, I_T = 5MA and E_{A2} = 60V.
   2. A three resistor parallel current divider in which I_{R3} is one-third of I_{R1} and R_2 is twice R_1.
   3. A balanced Wheatstone Bridge.

b. Test and review questions can be found in:
   1. Grob, Basic Electronics.
   2. Georgia, Electronics Technology, Phase A, Unit 21-A.
   3. Heathkit, DC Electronics.
   4. MAVCC, Basic Electronics 1.

INSTRUCTIONAL MATERIALS

Student Manuals:

a. Meade, Programmed Projects
b. Georgia, Electronics Technology, Phase A, Unit 21-A
c. Heathkit, DC Electronics

Tools and Equipment:

g. 100 ohm ½-watt 1% resistor
h. 100 ohm ½-watt 5% resistor
i. 200 ohm ½-watt 5% resistor
j. 68 ohm ½-watt 5% resistor
k. 10 ohm ½-watt 1% resistor
l. 22 ohm ½-watt 5% resistor
m. 10K ohm ½-watt 5% resistor
n. 2200 ohm ½-watt 5% resistor
o. 4700 ohm ½-watt 5% resistor
p. 5100 ohm ½-watt 5% resistor
q. 100K ohm potentiometer (built into ET-3100)
r. Slide switch, DPDT

TASK

ITI-17 Calculating and measuring electrical values in AC capacitance

PERFORMANCE OBJECTIVE

Calculate and measure electrical values in AC capacitance circuits.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Capacitors in AC circuits
    1. Current-voltage relationships
    2. Capacitive reactance
    3. Ohm's law in capacitance circuits
b. RC circuits
    1. Series RC circuits
    2. Impedance
    3. Phase shift
    4. Power in AC circuits
    5. Parallel RC circuits
c. Applications of capacitive circuits

(Continued on back)

Provide Practical Application On:

a. RC circuits
b. Capacitor applications
c. Calculating capacitive reactance in series and parallel circuits

INSTRUCTIONAL MATERIALS

Textbooks:

a. Heathkit, AC Electronics
b. MAVCC, Basic Electronics 1
c. Georgia, Electronics Technology, Phase A

Student Manuals:

a. Meade, Programmed Projects
b. Georgia, Electronics Technology, Phase A, Unit 32-A
c. Heathkit, AC Electronics

Tools and Equipment:

a. Experimenter or 30 VAC, 60 Hz source and sine wave signal generator
b. AC voltmeter
c. .001 microfarad capacitor
d. .039 microfarad capacitor
e. .1 microfarad capacitor
f. .47 microfarad capacitor
g. 4.7 k ohm ½-watt resistor
h. 47 k ohm ½-watt resistor

LAB HOURS	9
CLASS HOURS	3

EVALUATION (ITI-17)

a. Given a set of diagrams for AC series and parallel capacitive circuits, the student will correctly calculate the capacitive reactance in the circuits and determine the phase relationship between E and I.

b. Test and review questions can be found in:
   1. Grob, Basic Electronics.
   2. Meade, Programmed Projects.
   3. Heathkit, AC Electronics.
   4. Georgia, Electronics Technology, Phase A, Unit 32-A.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

1. Capacitive voltage dividers
2. Low-pass filter
3. High-pass filter
4. Decoupling network
5. Coupling network
6. Phase shift network

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TASK

ITI-18 Measuring inductance in series RL circuits

PERFORMANCE OBJECTIVE

Measure inductance in series RL circuits.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Inductor types and symbols
b. Inductors in AC circuits
    1. Current-voltage relationship
    2. Inductive reactance
    3. Ohm's law in inductive circuit
    4. Mutual inductance
    5. Inductors in series and in parallel
    6. Q
c. RL circuits
    1. Series RL circuits
    2. Impedance
    3. Phase shift
    4. Power
    5. Parallel RL circuits
d. Applications of inductive circuits

INSTRUCTIONAL MATERIALS

Textbooks:

a. Heathkit, AC Electronics
b. MAVCC, Basic Electronics 1
c. Georgia, Electronics Technology, Phase A
d. Grob, Basic Electronics

Student Manuals:

a. Georgia, Electronics Technology, Phase A, Units 27-A, 29-A and 30-A
b. Meade, Programmed Projects
c. Heathkit, AC Electronics

Tools and Equipment:

a. AC voltmeter (Heathkit IM-17 or equivalent)
b. Experimenter or DC power supply, 30v 60 Hz source and sine wave
c. Signal generator
d. 4.5 henry Iron-core choke
e. 45 to 110mH variable inductor
f. 2 1-kilohm, ½-watt resistor
g. Neon lamp
h. Alignment tool

LAB HOURS 9

CLASS HOURS 3

EVALUATION (ITI-18)

a. Given a diagram of an inductive circuit, the student will draw a diagram illustrating the phase relationship between current and voltage.

b. Given a series RL circuit, the student will compute inductive reactance in ohms when the inductance in henrys and the frequency of operations are known.

c. Given a series RL circuit, the student will calculate the impedance of the circuit.

d. Test and review questions can be found in:
   1. Heathkit, AC Electronics.
   2. MAVCC, AC Unit III.
   3. Meade, Programmed Projects.
   4. Grob, Basic Electronics.
   5. Georgia, Electronics Technology, Phase A, Units 27-A, 29-A and 30-A.

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TASK

ITI 19 Calculating capacitance and time constants for RC circuits

PERFORMANCE OBJECTIVE

Calculate capacitance and time constants for RC circuits.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Inductance
    1. Self-induction
    2. Inductors
    3. Schematic symbols for the inductor
    4. Time constant of an inductor
    5. Unit of inductance
b. Capacitance
    1. Unit of capacitance
    2. Factors determining capacitance
c. Capacitors
    1. Charging the capacitor
    2. Discharging the capacitor

(Continued on back)

Provide Demonstration On:

a. Types of inductors and capacitors
b. Mathematical applications for calculating inductance and capacitance in RC circuits

Provide Practical Application On:

Diagraming, constructing calculating parameters and measuring values in series and parallel RC circuits

INSTRUCTIONAL MATERIALS

Textbooks:

a. Grob, Basic Electronics
b. Georgia, Electronics Technology, Phase A
c. Heathkit, DC Electronics
d. MAVCC, Basic Electronics 1

Student Manuals:

a. Meade, Programmed Projects
b. Georgia, Electronics Technology, Phase A, Unit 33-A
c. Heathkit, DC Electronics

Tools and Equipment:

a. ET-3100 Electronic Design Experimenter or equivalent
b. Volt-ohm-meter with test leads
c. 50 microfarad 15 volt electrolytic capacitor
d. 500 microfarad 15 volt electrolytic capacitor
e. 100 ohm ½-watt 5% resistor
f. DPDT slide switch

(Continued on back)

LAB HOURS	9
CLASS HOURS	3

EVALUATION (ITI-19)

a. Given the tools and equipment listed for this unit, the student will diagram, construct and calculate the parameters of and measure to values in a series RC circuit and in a parallel RC circuit.

b. Test and review questions can be found in:
   1. Grob, Basic Electronics.
   2. Meade, Programmed Projects.
   3. MAVCC, Units V and VI.
   4. Georgia, Electronics Technology, Phase A, Unit 33-A.
   5. Heathkit, DC Electronics.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

   3. Types of capacitors
   4. Schematic symbol for the capacitor

d. RC time constants

e. Capacitors in combination
   1. In parallel
   2. In series

f. Mathematical applications
   1. Calculating total capacitance in networks
   2. Calculating RC time constants
   3. Solving time constant problems

INSTRUCTIONAL MATERIALS

Tools and Equipment:

g. Clock or watch with sweep-second hand

h. 100K ohm potentiometer (built into ET-3100)

i. 10 microfarad electrolytic capacitor

j. 100 ohm 2-watt 10% resistor

k. Lamp socket

l. Lamp

m. Relay

TASK

ITI-20 Measuring AC values for LF circuits

PERFORMANCE OBJECTIVE

Measure AC values for LF circuits.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Types of AC meters,
    1. Rectifier-type, moving coil meters
    2. Moving vane meters
    3. Thermocouple meters
    4. Clamp-on meters
b. Using AC meters
c. Oscilloscopes
d. AC circuits containing only resistance
    1. Basic AC circuit calculations
    2. Series AC circuit calculations
    3. Parallel AC circuit calculations
    4. Power in AC circuits

Provide Demonstration On:

a. Types of AC meters
b. Proper operation of AC meters
c. Measuring voltage and current in AC circuit

Provide Practical Application On:

a. Using test instruments to measure voltage and current in simple AC circuits
b. Making calculations in AC circuits

INSTRUCTIONAL MATERIALS

Textbooks:

a. Heathkit, AC Electronics
b. Training and Retraining, Inc., Basic Electricity/Electronics
c. Grob, Basic Electronics
   Georgia, Electronics Technology, Phase A

A/Vs:

Georgia, Electronics Technology, Phase A, "Important AC Units and Terms," slide/tape 26-A

Student Manuals:

a. Georgia, Electronics Technology, Phase A, Unit 26-A
b. Heathkit, AC Electronics

Tools and Equipment:

a. Experimenter or 15v, 60 Hz source
b. VOM

(Continued on back)

LAB HOURS ☐

CLASS HOURS ☐

EVALUATION (ITI-20)

a. Given a set of simple, series and parallel AC circuits containing only resistance, the student will correctly calculate electrical quantities and correctly measure voltage and current in the circuits using AC test meters.

b. Test and review questions can be found in:
   1. Heathkit, AC Electronics.
   2. Grob, Basic Electronics.
   3. Georgia, Electronics Technology, Phase A, Unit 26-A.

INSTRUCTIONAL MATERIALS

Tools and Equipment:

c. 470 ohm ½-watt resistor
d. 1 K ohm ½-watt resistor
e. Oscilloscope
f. Audio generator

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TASK

PPM-01 Identifying the nature of force

PERFORMANCE OBJECTIVE

Identify the nature of force.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Force
    1. Force and stationary objects
    2. Force and work
b. Standards of measurement
    1. English system
    2. Metric system
c. Direction of force
    1. Horizontal
    2. Vertical
    3. Slanted
    4. Angle to one another
    5. Vertex
d. Gravity
e. Weight versus mass

(Continued on back)

Provide Practical Application On:

Identifying types of working forces from pictures or in a plant

INSTRUCTIONAL MATERIALS

Textbooks:

Olivio and Olivio, Fundamentals of Applied Physics

Student Manuals:

Plant Engineering Training Systems, Elements of Mechanics, Lesson One

LAB HOURS	1
CLASS HOURS	2

EVALUATION (PPM-01)

Given pictures or live examples of various activities in a plant, the student will accurately identify the type of working force used.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

f. Equilibrium
    1. Static forces
    2. Static balance
    3. Neutral equilibrium
    4. Stable
    5. Unstable
g. Action forces
    1. External
    2. Internal
    3. Concurrent
    4. Parallel
    5. Opposite
    6. Tension
    7. Compression
    8. Torque
    9. Shear
h. Application of forces in the plant

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TASK

PPM-02 Identifying physical properties of motion

PERFORMANCE OBJECTIVE

Identify physical properties of motion.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

- a. Motion
- b. Gravity
  - 1. Sir Isaac Newton
  - 2. Galileo
  - 3. Distance = acceleration x time^2
- c. Velocity
- d. Acceleration
- e. Principles of motion
  - 1. Linear
  - 2. Rotary
  - 3. Absolute
  - 4. Relative
  - 5. Harmonic

(Continued on back)

Provide Demonstration On:

Working motion problems

Provide Practical Application On:

Working problems on velocity, acceleration and deceleration

INSTRUCTIONAL MATERIALS

Textbooks:

Olivio and Olivio, *Fundamentals of Applied Physics*

Student Manuals:

Plant Engineering Training Systems, *Elements of Mechanics, Lesson Two*

LAB HOURS 1

CLASS HOURS 2

EVALUATION (PPM-02)

Given an overview of the principles of motion, the student will correctly identify the basic principles of motion and work specific problems related to properties of motion.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

f. Newton's Laws of Motion
    1. First Law of Motion
    2. Inertia
    3. Second Law of Motion
    4. Third Law of Motion

g. Linear Motion

h. Circular motion
    1. Curved motion
    2. Centripetal and centrifugal forces

i. Rotary motion

j. Relative motion

k. Harmonic motion
    1. Equilibrium
    2. Amplitude
    3. Frequency

TASK

PPM-03 Identifying principles of work and energy

PERFORMANCE OBJECTIVE

Identify principles of work and energy.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Work
  1. Types of work
  2. Vertical and horizontal force
b. Power
  1. Amount of work per time
  2. Foot-pounds per second
  3. Horsepower
c. Energy
  1. Kinetic
  2. Potential
d. Kinetic energy
  1. Definition
  2. Kinetic energy =

$$\frac{1}{2}\,\frac{MV^2}{32\ \text{ft/sec}^2}$$

  3. Calculating kinetic energy
e. Potential energy
f. Transformation of energy
g. Collision and conservation of momentum
h. Types of collision
  1. Imperfectly elastic
  2. Perfectly elastic
  3. Perfectly inelastic

INSTRUCTIONAL MATERIALS

Textbooks:

Olivio and Olivio, Fundamentals of Applied Physics

Student Manuals:

Plant Engineering Training Systems, Elements of Mechanics, Lesson Three

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LAB HOURS 1

CLASS HOURS 2

EVALUATION (PPM-03)

Given an overview of the principles of work as related to energy, the student will define the principles of work and relate these to basic principles of energy. The completed task must comply with the instructor's specifications.

TASK

PPM-04 Identifying principles of simple machines

PERFORMANCE OBJECTIVE

Identify basic principles of simple machines.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Simple machines
   1. Lever
   2. Wheel and axle
   3. Pulley
   4. Inclined plane
   5. Screw
b. Principle of work
c. The lever
   1. Fulcrum
   2. First, second and third class
   3. Calculating lever mechanical advantage
d. The inclined plane
   1. Uses
   2. Mechanical advantage
   3. Grade

(Continued on back)

Provide Practical Application On:

Identifying practical applications of simple machines

INSTRUCTIONAL MATERIALS

Textbooks:

Olivio and Olivio, Fundamentals of Applied Physics

Student Manuals:

Plant Engineering Training Systems, Elements of Mechanics, Lesson Four

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LAB HOURS	1
CLASS HOURS	2

EVALUATION (PPM-04)

Given basic principles of simple machines, the student will accurately identify applications of simple machines in the lab.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

e. The screw
f. The wedge
    1. Description
    2. The cam
g. Wheel and axle
h. Pulleys
    1. Fixed
    2. Movable
    3. Block and tackle
i. Jacking screws

TASK

PPM-05 Calculating area and volume

PERFORMANCE OBJECTIVE

Calculate area and volume.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Units of measurement
  1. Pound
  2. Foot
  3. Second
  4. Degree
  5. Volt

b. Measurements
  1. Linear measurements
  2. Weight
  3. Liquid measure
  4. Dry measure
  5. Time

c. Area
  1. Square measure
  2. Triangle
  3. Trapezoid
  4. Circle
  5. Hollow rectangle
  6. Hollow circle
  7. Cylinder

d. Finding an area within another area

e. Volume
  1. Divide into geometric shapes and add areas
  2. Displacement method (for irregular shapes)
  3. Capacity method (irregular tank or cylinder)

INSTRUCTIONAL MATERIALS

Textbooks:

Olivio and Olivio, Fundamentals of Applied Physics

Student Manuals:

Plant Engineering Training Systems, Elements of Mechanics, Lesson Six

LAB HOURS	1
CLASS HOURS	2

EVALUATION (PPM-05)

Given an object, the student will measure its dimensions and correctly calculate the volume of the object by the most accurate method. Work must comply with the instructor's specified requirements.

TASK

PPM-06 Identifying properties of friction

PERFORMANCE OBJECTIVE

Identify properties of friction.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Problems caused by friction
b. Laws and conditions of friction
c. Classes of friction
    1. Static
    2. Kinetic
d. Application of friction
e. Angle of repose

Provide Practical Application On:

a. Calculating angle of repose
b. Calculating angle of friction

INSTRUCTIONAL MATERIALS

Textbooks:

Olivio and Olivio, *Fundamentals of Applied Physics*

Student Manuals:

Plant Engineering Training Systems, *Elements of Mechanics, Lesson Ten*

LAB HOURS	2
CLASS HOURS	2

EVALUATION (PPM-06)

Given specifications for an object to be stored in bulk, the student will make all calculations relative to safe storage including angle of repose and angle of friction. The calculations must comply with the instructor's requirements.

TASK

DCM-01 Understanding fundamentals of electrical theory and electrical measurement

PERFORMANCE OBJECTIVE

Demonstrate a knowledge of the fundamentals of electrical theory and the use of electric test meters and circuit diagram symbols.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Atoms
b. Electrons
c. Voltage
d. Current
e. Resistance
f. Electrical measurements and circuits
    1. Ammeter
    2. Voltmeter
    3. Ohmmeter
    4. Circuits
    5. Fuses
    6. Symbols
    7. Circuit diagrams

Provide Demonstration On:

Electric test meters

Provide Practical Application On:

Making basic electrical measurements in a DC circuit using test meters

INSTRUCTIONAL MATERIALS

Textbooks:

a. Grob, Basic Electronics
b. MAVCC, Basic Electronics 1
c. Singer, Basic Mathematics for Electricity and Electronics
d. Georgia, Electronics Technology, Phase A

Student Manuals:

Georgia, Electronics Technology, Phase A, Unit 9-A

Tools and Equipment:

a. Ammeter
b. Voltmeter
c. Ohmmeter
d. Fuses
e. Live DC circuit

LAB HOURS	3
CLASS HOURS	6

EVALUATION (DCM-01)

a. Given a diagram of an atom, the student will correctly identify electrons, protons, neutrons, the nucleus and orbit.

b. Given a list of basic electrical terms and definitions covered in the unit, the student will correctly match each term with its definition.

c. Given a chart of electrical symbols covered in the unit, the student will correctly identify all symbols on the chart.

d. Given a set of circuit diagrams covered in the unit, the student will correctly identify the components in each diagram.

e. Given a ammeter, a voltmeter and an ohmmeter, the student will correctly identify each meter and describe its basic function as covered in the unit.

f. Test and review questions are available in:
   1. Singer, Basic Mathematics for Electricity and Electronics, Chapter 1.
   2. MAVCC, Basic Electronics 1, Unit 1.
   3. Georgia, Electronics Technology, Phase A, Student Tests, Unit 9-A.
   4. Grob, Basic Electronics.

TASK

DCM-02 Making calculations using Ohm's law

PERFORMANCE OBJECTIVE

Make calculations with the Ohm's law formula using fractions, decimals and exponents.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Fractions
b. Ohm's law
c. Decimal numbers
d. The metric system
e. Formulas
f. Positive and negative numbers
g. Exponents
h. Equations

Provide Practical Application On:

a. Solving for electrical values using Ohm's law
b. Verifying Ohm's law calculations
c. Solving algebraic equations using exponents

INSTRUCTIONAL MATERIALS

Textbooks:

a. MAVCC, Basic Electronics 1
b. Singer, Basic Mathematics for Electricity and Electronics
c. Georgia, Electronics Technology, Phase A
d. Grob, Basic Electronics

Student Manuals:

a. Meade, Programmed Projects
b. Georgia, Electronics Technology, Phase A, Unit 15-A

Tools and Equipment:

a. VOM
b. Basic electricity/electronics trainer
c. Variable voltage DC supply

LAB HOURS	3
CLASS HOURS	6

EVALUATION (DCM-02)

a. Given the Ohm's law formula and a set of problems involving fractions, decimals, positive and negative numbers and exponents, the student will correctly calculate the missing values.

b. Test and review questions can be found in:
   1. Singer, Basic Mathematics for Electricity and Electronics, Chapters 2 and 3.
   2. MAVCC, Basic Electronics 1, Unit IX.
   3. Georgia, Electronics Technology, Phase A, Student Tests, Unit 15-A.
   4. Grob, Basic Electronics 1.

TASK

DCM-03 Measuring current in DC circuits

PERFORMANCE OBJECTIVE

Demonstrate a knowledge of fundamentals of direct electrical current and measure current in a live DC circuit.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Composition of matter
b. Electrostatics
    1. Coulomb's Law
    2. Ions
    3. Sources of electricity
c. Current flow
    1. Conductors and insulators
    2. Batteries
    3. Random drift and directed drift
d. Electric circuit
e. Current measurement
    1. The coulomb
    2. Powers of ten and scientific notation
    3. The ampere, milliamps and microamps

(Continued on back)

Provide Practical Application On:

Measuring direct current in a live circuit using a VOM

INSTRUCTIONAL MATERIALS

Textbooks:

a. Grob, Basic Electronics
b. MAVCC, Basic Electronics 1
c. Singer, Basic Mathematics for Electricity and Electronics
d. Heathkit, DC Electronics
e. Georgia, Electronics Technology, Phase A

A/Vs:

Georgia, Electronics Technology, Phase A, "Measuring Electrical Current," slide/tape

Student Manuals:

a. Heathkit, DC Electronics, Student Workbook
b. Georgia, Electronics Technology, Phase A, Units 10-A and 13-A

Tools and Equipment:

a. Breadboarding trainer
b. VOM
c. DC variable power supply

LAB HOURS	3
CLASS HOURS	6

EVALUATION (DCM-03)

a. Given a live DC circuit and a VOM, the student will correctly measure and compare at two points on the circuit and at two different power levels. The student will correctly convert amps to milliamps and microamps.

b. Test and review questions can be found in:
   1. Heathkit, DC Electronics, Unit 1 and Student Workbook, Unit 1.
   2. Singer, Basic Mathematics for Electricity and Electronics, Chapter 3.
   3. Georgia, Electronics Technology, Phase A, Student Tests, Units 10-A and 13-A.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

   4. Ammeters

f. Charging units of measurement

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TASK

DCM-04 Measuring voltage in DC circuits

PERFORMANCE OBJECTIVE

Demonstrate a knowledge of the fundamentals of electrical voltage and the ability to measure voltage in a given DC circuit.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Voltage
b. Electromotive force
c. Potential difference
d. Batteries
    1. Dry cell
    2. Lead-acid
e. Battery connections
    1. Series aiding
    2. Series opposing
    3. Parallel
    4. Series parallel
f. Voltage rises and voltage drops
g. The concept of ground
h. Voltage measurement
i. Shorts and opens
j. Soldering

Provide Demonstration On:

a. Voltage measurement
b. Voltage rises and voltage drops
c. Shorts and opens

Provide Practical Application On:

Measuring voltage rises and voltage drops

INSTRUCTIONAL MATERIALS

Textbooks:

a. Grob, Basic Electronics
b. MAVCC, Basic Electronics 1
c. Heathkit, DC Electronics
d. Georgia, Electronics Technology, Phase A

A/Vs:

Georgia, Electronics Technology, Phase A, "Measuring Electrical Voltage," slide/tape

Student Manuals:

a. Heathkit, DC Electronics, Student Workbook
b. Georgia, Electronics Technology, Phase A, Units 11-A and 24-A
c. Meade, Programmed Projects

Tools and Equipment:

a. ET-3100 Electronic Design Experimenter or equivalent

(Continued on back)

LAB HOURS	3
CLASS HOURS	6

EVALUATION (DCM-04)

a. Given a live DC circuit and a voltmeter, the student will correctly measure the applied voltage and voltage drops.

b. Test and review questions can be found in:
   1. Heathkit, DC Electronics, Unit 2 and Student Workbook, Unit 2.
   2. MAVCC, Basic Electronics 1, Unit X.
   3. Georgia, Electronics Technology, Phase A, Student Tests, Units 11-A and 24-A
   4. Grob, Basic Electronics.

INSTRUCTIOANL MATERIALS

Tools and Equipment:

b. Voltmeter with test leads
c. 1000 ohm, 1%, ½-watt resistor
d. 2 1000 ohm, 5%, ½-watt resistors
e. Slide switch
f. Soldering iron and solder

TASK

DCM-05 Calculating and measuring resistance in DC circuits

PERFORMANCE OBJECTIVE

Calculate and measure partial and total resistance in DC series and parallel circuits.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. The ohm
b. Resistivity
c. Conductance
d. Factors determining resistance
e. Resistors
    1. Types
    2. Connecting
f. Resistance measurements
    1. In series
    2. In parallel
g. Light dependent resistors
h. Resistor color code.

Provide Practical Application On:

a. Color code
b. Using the ohmmeter
c. Measuring resistance
d. Light dependent resistors

INSTRUCTIONAL MATERIALS

Textbooks:

a. MAVCC, Basic Electronics 1
b. Heathkit, DC Electronics
c. Georgia, Electronics Technology, Phase A

A/Vs:

a. Georgia, Electronics Technology, Phase A "Resistor Color Code," slide/tape

(Continued on back)

Student Manuals:

a. Heathkit, DC Electronics
b. Georgia, Electronics Technology, Phase A, Units 8-A and 12-A

Tools and Equipment:

a. Assorted resistor
b. VOM
c. Variable DC power supply

LAB HOURS 3
CLASS HOURS 6

EVALUATION (DCM-05)

a. Given a live DC resistive circuit and an ohmmeter, the student will accurately identify the resistor types and values in the circuit, compute the resistance in the circuit and measure the resistance in the circuit.

b. Test and review questions can be found in:
   1. Heathkit, DC Electronics, Unit 3 and Student Workbook, Unit 3.
   2. Georgia, Electronics Technology, Phase A, Student Tests, Units 8-A and 12-A.
   3. MAVCC, Basic Electronics 1, Unit X and XI.
   4. Grob, Basic Electronics.

INSTRUCTIONAL MATERIALS

Tools and Equipment:

d. Assorted resistors
e. Ohmmeter with test leads
f. 200 ohm potentiometer
g. 120 ohm thermistor
h. 100 k ohm thermistor
i. Incandescent lamp #49
j. Lamp socket
k. 1/16-amp fuse
l. Soldering iron and solder
m. ET-3100 Electronic Design
n. Light dependent resistor
o. 220 ohm, 2-watt, 10% resistor

A/Vs:

b. Georgia, Electronics Technology, Phase A, "Use of the Ohmmeter," slide/tape (Part #2)
c. Georgia, Electronics Technology, Phase A, "Using the Ohmmeter to Troubleshoot," slide/tape

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TASK

DCM-06 Calculating voltage, current and resistance in DC series circuits

PERFORMANCE OBJECTIVE

Demonstrate the ability to calculate voltage, current and resistance in DC series circuits.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Voltage in series circuits
b. Current in series circuits
c. Resistance in series circuits
d. Ohm's law
    1. For part of a series circuit
    2. For total values in a series circuit
e. Control of current in series circuits
f. Formulas involving addition and subtraction
g. Use of the memory wheel for solving problems

Provide Practical Application On:

Locating faulty components in a series circuit using a voltmeter

INSTRUCTIONAL MATERIALS

Textbooks:

a. MAVCC, Basic Electronics 1
b. Singer, Basic Mathematics for Electricity and Electronics
c. Grob, Basic Electronics
d. Georgia, Electronics Technology, Phase A

Student Manuals:

a. Meade, Programmed Projects
b. Georgia, Electronics Technology, Phase A, Unit 18-A

Tools and Equipment:

a. Variable voltage power supply
b. Single-pole single-throw switch

(Continued on back)

LAB HOURS	3
CLASS HOURS	6

EVALUATION (DCM-06)

a. Given a set of live DC series circuits with various combinations of voltage, resistors and amperage, the student will correctly calculate the unknown values of total voltage and voltage drops, resistance or amperage in each circuit and verify the calculations using a VOM.

b. Test and review questions can be found in:
   1. Singer, Basic Mathematics for Electricity and Electronics, Chapter 4.
   2. MAVCC, Basic Electronics 1, Unit X.
   3. Georgia, Electronics Technology, Phase A, Student Tests, Unit 18-A.
   4. Grob, Basic Electronics.

TASK

DCM-07 Calculating total voltage, total current and total resistance in DC parallel circuits

PERFORMANCE OBJECTIVE

Demonstrate the ability to calculate the total voltage, total current and total resistance in parallel circuits.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Total voltage in parallel circuits
b. Total current in parallel circuits
c. Total resistance in parallel circuits
d. Ohm's law
e. Division of current in a parallel circuit
f. Addition and subtraction of fractions
g. Fractions in formulas and equations
h. Opens and shorts in parallel circuits

Provide Practical Application On:

Hooking up, measuring and analyzing parallel circuits

INSTRUCTIONAL MATERIALS

Textbooks:

a. MAVCC, Basic Electronics 1
b. Singer, Basic Mathematics for Electricity and Electronics
c. Georgia, Electronics Technology, Phase A
d. Grob, Basic Electronics

Student Manuals:

a. Georgia, Electronics Technology, Phase A, Unit 19-A
b. Meade, Programmed Projects

Tools and Equipment:

a. Assorted resistors
b. Variable DC power supply
c. VOM

LAB HOURS	3
CLASS HOURS	6

EVALUATION (DCM-07)

a. Given a live parallel resistive DC circuit containing resistors of different values, the student will accurately calculate and measure the voltage, current and resistance of parts of the circuit and for the total circuit using appropriate meters.

b. Test and review questions can be found in:
   1. MAVCC, Basic Electronics 1, Unit XI.
   2. Singer, Basic Mathematics for Electricity and Electronics, Chapter 5.
   3. Georgia, Electronics Technology, Phase A, Student Tests, Unit 19-A.
   4. Grob, Basic Electronics.

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TASK

DCM-08 Calculating and measuring electrical quantities in combination DC circuits

PERFORMANCE OBJECTIVE

Calculate and measure electrical quantities in combination DC circuits.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Combination circuits
b. Simplifying series-parallel circuits
c. Equivalent circuits
d. Voltage dividers
e. Grounds and voltage polarity
f. Opens and shorts
g. Schematic symbols

Provide Demonstration On:

a. Steps in simplifying a series parallel circuit
b. A voltage divider

Provide Practical Application On:

a. Measuring and calculating quantities in combination circuits
b. Constructing a voltage divider

INSTRUCTIONAL MATERIALS

Textbooks:

a. Grob, Basic Electronics
b. MAVCC, Basic Electronics 1
c. Singer, Basic Mathematics for Electricity and Electronics
d. Georgia, Electronics Technology, Phase A

Student Manuals:

a. Georgia, Electronics Technology, Phase A Unit 20-A
b. Meade, Programmed Projects

Tools and Equipment:

a. DC power supply
b. VOM
c. Two 1000, one 1500 and two 2200 ohm resistors, ½W

(Continued on back)

LAB HOURS	3
CLASS HOURS	6

EVALUATION (DCM-08)

a. Using the components listed for this unit, the student will diagram a series parallel circuit, will calculate the total and branch quantities and will then construct the live circuit and measure the electrical quantities.

b. Test and review questions can be found in:
   1. Singer, Basic Mathematics for Electricity and Electronics, Chapter 6.
   2. Georgia, Electronics Technology, Phase A, Student Tests, Unit 20-A.
   3. Grob, Basic Electronics.
   4. Meade, Programmed Projects.

INSTRUCTIONAL MATERIALS

Tools and Equipment:

d. Switch, SPST
e. 12-v lamp or equivalent

TASK

DCM-09 Calculating power in DC circuits

PERFORMANCE OBJECTIVE

Calculate power in DC circuits.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

- a. Ohm's law
  - 1. Finding current
  - 2. Finding voltage
  - 3. Finding resistance
- b. Power and wattage
  - 1. Work and power
  - 2. Current, voltage and power
  - 3. Power dissipation in resistors
  - 4. Total power in electric circuits
- c. Equations derived from Ohm's law and the basic power formula
- d. Square root of a number

Provide Practical Application On:

- a. Verifying Ohm's law
- b. Calculating power

INSTRUCTIONAL MATERIALS

Textbooks:

- a. MAVCC, Basic Electronics 1
- b. Singer, Basic Mathematics for Electricity and Electronics
- c. Heathkit, DC Electronics
- d. Georgia, Electronics Technology, Phase A
- e. Grob, Basic Electronics

Student Manuals:

- a. Georgia, Electronics Technology, Phase A, Unit 16-A
- b. Meade, Programmed Projects

Tools and Equipment:

- a. ET-3100 Electronic Design Experimenter or equivalent
- b. Volt-ohm-meter
- c. 1000 ohm, 1% resistor

(Continued on back)

LAB HOURS 3

CLASS HOURS 6

EVALUATION (DCM-09)

a. Given the equipment, components and test instruments listed in this unit, the student will diagram a simple DC circuit, construct the circuit, measure the electrical quantities and accurately calculate watts of power in the circuit.

b. Test and review questions can be found in:
   1. Heathkit, DC Electronics, Unit 4.
   2. Georgia, Electronics Technology, Phase A, Student Tests, Unit 16-A.
   3. Meade, Programmed Projects.
   4. MAVCC, Basic Electronics I, Units VII and IX.
   5. Singer, Basic Mathematics for Electricity and Electronics, Chapter 7.

INSTRUCTIONAL MATERIALS

Tools and Equipment:

d. 100 ohm, 1% resistor
e. 1200 ohm, 5% resistor, .5W
f. 22K ohm, 5%, ½ watt resistor
g. 33K ohm, 1% resistor
h. 1K ohm, 1% resistor
i. 2K ohm, 5%, ½ watt resistor
j. 100K ohm potentiometer (built into ET-3100)

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TASK

DCM-10 Applying fundamentals of magnetism and electromagnetism

PERFORMANCE OBJECTIVE

Apply fundamentals of magnetism and electromagnetism.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. The magnetic field
   1. Lines of force
   2. Theory of magnetism
b. Electricity and magnetism
   1. Current flow and magnetism
   2. The electromagnet
   3. Magnetic quantities
   4. Ohm's law for magnetic quantities
   5. Systems of measurement for magnetic quantities
c. Induction
   1. Magnetic induction
   2. Electromagnetic induction

(Continued on back)

Provide Demonstration On:

a. Illustration of the magnetic field using magnet and iron filings
b. Examples of common applications of magnets and electromagnets

Provide Practical Application On:

Constructing and demonstrating the properties of an electromagnet

INSTRUCTIONAL MATERIALS

Textbooks:

a. MAVCC, Basic Electronics 1
b. Heathkit, DC Electronics
c. Georgia, Electronics Technology, Phase A
d. Grob, Basic Electronics

A/Vs:

Georgia, Electronics Technology, Phase A, "Basic Introduction to Magnetism," slide/tape

Student Manuals:

Georgia, Electronics Technology, Phase A, Unit 25-A

Tools and Equipment:

a. ET-3100 Electron Design Experimenter or equivalent
b. Volt-ohm-meter
c. Compass
d. 100 ohm, 2-watt, 10% resistor

(Continued on back)

LAB HOURS	3
CLASS HOURS	6

EVALUATION (DCM-10)

a. Given an assortment of magnetic and electromagnetic devices, the student will correctly identify by name, describe the function and application of each device and compute the ampere-turns magnetic strength of an electromagnet in a given circuit.

b. Test and review questions can be found in:
   1. Heathkit, DC Electronics, Unit 5.
   2. MAVCC, Basic Electronics 1, Unit XIII.
   3. Georgia, Electronics Technology, Phase A, Student Tests, Unit 25-A.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

d. Applications of magentism and electromagnetism
   1. AC generator
   2. DC generator
   3. Relay
   4. Reed switch and relay
   5. Record pickup
   6. Loudspeaker
   7. Magnetic tape
   8. DC motor
   9. Meter
   10. Computer memories
   11. Magnetic deflection of electron beams

e. The left-hand rule
   1. For coils
   2. For conductors

INSTRUCTIONAL MATERIALS

Tools and Equipment:

e. Slide switch
f. Hook-up wire
g. Permanent magnet
h. Magnetic reed switch
i. Relay
j. Incandescentlamp
k. Lamp socket
l. Soldering iron and solder
m. 1K ohm potentiometer (built into ET-3100)

443

TASK

LFM-01 Calculating values for a right triangle

PERFORMANCE OBJECTIVE

Demonstrate the ability to calculate the unknown values of a right triangle by using trigonometric functions.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Angles
b. Radians
c. Triangles
d. Right triangles
    1. Finding the acute angles
    2. Finding the sides
e. Trigonometric formulas
    1. Tangent of an angle
    2. Sine of an angle
    3. Cosine of an angle
f. Table of trigonometric functions

Provide Demonstration On:

Illustrating the properties of a right triangle

Provide Practical Application On:

Using trigonometric formulas

INSTRUCTIONAL MATERIALS

Textbooks:

Singer, Basic Mathematics for Electricity and Electronics

LAB HOURS 3
CLASS HOURS 3

EVALUATION (LFM-01)

a. Given a set of trigonometric problems and a table of trigonometric functions, the student will correctly solve for unknown values.

b. Test and review questions can be found in Singer, Basic Mathematics for Electricity and Electronics.

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TASK

LFM-02 Identifying the characteristics of AC sine waves

PERFORMANCE OBJECTIVE

Identify characteristics of AC sine waves.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

- a. Difference between alternating current and direct current
- b. Practical applications of alternating current
- c. Alternating current
  - 1. Electromagnetic induction
  - 2. Simple alternating current generator
- d. The sinusoidal wave form of AC voltage or current
  - 1. Frequency
  - 2. Period
  - 3. Wave length

(Continued on back)

Provide Demonstration On:

- a. Using the oscilloscope
- b. Interpreting wave forms

Provide Practical Application On:

Using the oscilloscope to measure AC values

INSTRUCTIONAL MATERIALS

Textbooks:

- a. Heathkit, AC Electronics
- b. MAVCC, Basic Electronics 1
- c. Georgia, Electronics Technology, Phase A

A/Vs:

Georgia, Electronics Technology, Phase A, "Introduction to Basic Oscilloscope Controls," slide/tape

Student Manuals:

Georgia, Electronics Technology, Phase A, Unit 28-A

Tools and Equipment:

- a. Oscilloscope
- b. Audio frequency generator
- c. DC variable power supply
- d. AC variable power supply
- e. VOM

(Continued on back)

LAB HOURS 3

CLASS HOURS 3

EVALUATION (LFM-02)

a. Using the equipment listed for this task and a 10 unit diameter circle, the student will construct a graph of a sine wave cycle with 15 degree increments and will calculate the RMS value.

b. Test and review questions can be found in:
   1. MAVCC, Basic Electronics 1.
   2. Heathkit, AC Electronics.
   3. Georgia, Electronics Technology, Phase A, Unit 28-A.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

e. AC values
   1. Peak value
   2. Peak-to-peak value
   3. Average value
   4. Effective value
   5. Period
   6. Frequency

f. Nonsinusoidal wave forms
   1. The square wave
   2. The triangular wave
   3. The sawtooth wave
   4. Fluctuating DC waves

INSTRUCTIONAL MATERIALS

Tools and Equipment:

f. Graph paper
g. Compass
h. Protractor
i. Ruler
j. Calculator

TASK

LFM-03 Computing turns, voltage, current and impedance ratios of transformers

PERFORMANCE OBJECTIVE

Compute turns, voltage, current and impedance ratios of transformers.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Transformer characteristics
   1. Mutual inductance
   2. Transformer action
   3. Transformer construction
   4. Symbols
b. Transformer theory
   1. Transformer with no load
   2. Transformer with load
c. Transformer ratios
   1. Voltage ratio
   2. Power ratio
   3. Current ratio

(Continued on back)

Provide Demonstration On:

Types of transformers

Provide Practical Application On:

a. The action of a transformer in an AC circuit
b. Solving problems of turns ratio, voltage ratio, current and impedance ratio

INSTRUCTIONAL MATERIALS

Textbooks:

a. Heathkit, AC Electronics
b. Grob, Basic Electronics
c. Georgia, Electronics Technology, Phase A

A/Vs:

Georgia, Electronics Technology, Phase A, "Transformer Impedance Ratio," slide/tape

Student Manuals:

a. Heathkit, AC Electronics
b. Georgia, Electronics Technology, Phase A, Unit 37-A

Tools and Equipment:

a. Experimenter or 15v 60 Hz source
b. Multimeter
c. 10 k ohm to 1740 ohm audio driver transformer

(Continued on back)

LAB HOURS 6

CLASS HOURS 3

EVALUATION (LFM-03)

a. When supplied with diagrams of transformers, the student will correctly solve problems of turns ratio, voltage ratio, current ratio and impedance ratio.

b. Test and review questions can be found in:
   1. Grob, Basic Electronics.
   2. Georgia, Electronics Technology, Phase A, Unit 37-A.
   3. Heathkit, AC Electronics.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

   4. Solving transformer problems
   5. Impedance ratio
d. Transformer losses
e. Transformer efficiency
f. Transformer applications
   1. Power distribution
   2. Electronic applications
   3. Autotransformer

INSTRUCTIONAL MATERIALS

Tools and Equipment:

d. 1000, ½-watt resistor
e. 100, ½-watt resistor
f. Filament transformer with HV windings

TASK

LFM-04 Determining reactance and impedance of a capacitor in either series or parallel circuits

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PERFORMANCE OBJECTIVE

Determine reactance and impedance of a capacitor in either series or parallel circuits.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Structure and function of a capacitor
b. Capacitance
c. Capacitors in parallel
d. Capacitors in series
e. Reactance of a capacitor
f. Impedance of a capacitor
g. Measurement of capacitance
h. Capacitor types
i. Color code
j. Symbols
k. Charge and discharge

Provide Demonstration On:

a. Types of capacitors
b. Symbols
c. Charging and discharging

Provide Practical Application On:

a. Charging and discharging
b. Using a capacitor testor
c. Calculating reactance and impedance

INSTRUCTIONAL MATERIALS

Textbooks:

a. Singer, Basic Mathematics for Electricity and Electronics
b. Georgia, Electronics Technology, Phase A
c. Grob, Basic Electronics
d. Training and Retraining, Inc., Basic Electricity/Electronics
e. Duarte, Electronics Assembly and Fabrication Methods
f. Heathkit, AC Electronics

Student Manuals:

a. Meade, Programmed Projects
b. Georgia, Electronics Technology, Phase A, Unit 31-A
c. Heathkit, AC Electronics

Tools and Equipment:

Various types of capacitors

LAB HOURS	3
CLASS HOURS	3

EVALUATION (LFM-04)

a. Given a set of diagrams of simple, series and parallel AC circuits containing capacitance, the student will correctly calculate impedance, reactance and capacitance.

b. Test and review questions can be found in:
   1. Singer, Basic Mathematics of Electricity.
   2. MAVCC, Basic Electronics 1.
   3. Grob, Basic Electronics.
   4. Georgia, Electronics Technology, Phase A, Unit 31-A.
   5. Heathkit, AC Electronics.

TASK

LFM-05 Drawing phasor diagrams and calculating operating values for series AC circuits

PERFORMANCE OBJECTIVE

Demonstrate the ability to draw phasor diagrams and to calculate the values for series AC circuits.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Phasors and phasor diagrams
b. Simple series AC circuits
    1. Containing only resistance
    2. Containing only inductance
    3. Containing only capacitance
c. The Pythagorea theorem
d. More complex series AC circuits
    1. Containing resistance and inductance
    2. Containing resistance and capacitance

(Continued on back)

Provide Demonstration On:

a. Measuring frequency and phase using the oscilloscope
b. Using the Time Measurement and Lissajous Pattern methods for measuring frequency

Provide Practical Application On:

a. Drawing phasor diagrams
b. Using the oscilloscope to measure frequency and phase angle

INSTRUCTIONAL MATERIALS

Textbooks:

a. Singer, Basic Mathematics for Electricity and Electronics
b. Georgia, Electronics Technology, Phase A

A/Vs:

Georgia, Electronics Technology, Phase A, "Measuring Frequency and Phase with a Scope," slide/tape

Student Manuals:

Georgia, Electronics Technology, Phase A, Unit 38-A

Tools and Equipment:

a. Dual trace oscilloscope
b. Two audio generators
c. Basic electronics trainer

LAB HOURS	9
CLASS HOURS	3

EVALUATION (LFM-05)

a. Given series AC circuits and the proper tools and equipment, the student will draw phasor diagrams and calculate electrical values for the circuits.

b. Test and review questions can be found in:
   1. Singer, Basic Mathematics for Electricity and Electronics.
   2. Georgia, Electronics Technology, Phase A, Unit 38-A.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

   3. Containing resistance, inductance and capacitance

e. Series resonance
   1. Finding the inductance to produce resonance
   2. Finding the capacitance to produce resonance

f. Values to be determined
   1. Current
   2. Total current
   3. Power
   4. Effective power
   5. Voltage
   6. Resistance
   7. Reactance
   8. Inductance
   9. Inductive reactance
   10. Impedance
   11. Phase angle
   12. Power factor
   13. Voltage drop
   14. Frequency
   15. Angle of lead
   16. Angle of lag
   17. Capacitance
   18. Resonant frequency

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TASK

LFM-06 Drawing phasor diagrams and calculating operating values for parallel AC circuits

PERFORMANCE OBJECTIVE

Demonstrate the ability to draw phasor diagrams and to calculate the values for parallel AC circuits.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Simple parallel AC circuits
   1. Containing only resistance
   2. Containing only inductance
   3. Containing only capacitance
b. More complex parallel AC circuits
   1. Containing resistance and inductance
   2. Containing resistance and capacitance
c. Parallel resonance
   1. Finding the inductance to produce resonance

(Continued on back)

Provide Demonstration On:

Using the oscilloscope and other test instruments to measure electrical values in AC parallel circuits

Provide Practical Application On:

a. Measuring electrical values in AC parallel circuits
b. Calculating values in AC parallel circuits

INSTRUCTIONAL MATERIALS

Textbooks:

a. Singer, Basic Mathematics for Electricity and Electronics
b. Georgia, Electronics Technology, Phase A

A/Vs:

Georgia, Electronics Technology, Phase A, "Measuring Frequency and Phase with a Scope," slide/tape

Student Manuals:

Georgia, Electronics Technology, Phase A, Units 34-A and 38-A

Tools and Equipment:

a. Dual trace oscilloscope
b. Two audio generators
c. Basic electronics trainer
d. VOM

LAB HOURS	9
CLASS HOURS	3

EVALUATION (LFM-06)

a. Given parallel AC circuits and the proper tools and equipment, the student will draw phasor diagrams and calculate and measure electrical values for the circuits.

b. Test and review questions can be found in:
   1. Singer, Basic Mathematics for Electricity and Electronics.
   2. Georgia, Electronics Technology, Phase A, Units 34-A and 38-A.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

   2. Finding the capacitance to produce resonance

d. Values to be determined for parallel AC circuits
   1. Current
   2. Total current
   3. Power
   4. Resistance
   5. Total resistance
   6. Reactance
   7. Inductance
   8. Impedance
   9. Total impedance
   10. Phase angle
   11. Power factor
   12. Capacitance
   13. Resonant frequency
   14. Series equivalent circuit
   15. In-phase current
   16. Reactive current

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TASK

HFM-01 Understanding fundamentals of tuned AC circuits

PERFORMANCE OBJECTIVE

Demonstrate a knowledge of the fundamentals of tuned AC circuits.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. RLC circuits
    1. Series RLC circuits
    2. Parallel RLC circuits
b. Resonance
c. Series resonance
d. Q and bandwidth in series resonant circuits
e. LC filters
    1. Band-pass filter
    2. Band-stop filter
    3. Low-pass filter
    4. High-pass filter
g. Solving problems
    1. Calculating values for series and parallel
    2. Solving for resonant frequency, capacitance and inductance in LC circuits

Provide Practical Application On:

a. Series resonance
b. Parallel resonance
c. LC filters and their response curves

INSTRUCTIONAL MATERIALS

Textbooks:

a. Heathkit, AC Electronics
b. Grob, Basic Electronics
c. Georgia, Electronics Technology, Phase A

Student Manuals:

a. Georgia, Electronics Technology, Phase A, Units 35-A and 36-A
b. Heathkit, AC Electronics

Tools and Equipment:

a. Experimenter or sine wave signal generator and 100 K ohm potentiometer
b. Volt-ohmmeter
c. AV voltmeter
d. 107 mH coil
e. .001 microfarad ceramic capacitor
f. Two 4700 ohm, ½ watt resistors
g. Two 1000 ohm resistors

(Continued on back)

LAB HOURS ☐

CLASS HOURS ☐

EVALUATION (HFM-01)

a. Given RLC circuits and the proper test instruments, the student will correctly calculate and measure electrical values.

b. Given LC circuits and the proper test instruments, the student will correctly calculate and measure resonant frequency, capacitance and inductance.

c. Test and review questions can be found in:
   1. Heathkit, AC Electronics.
   2. Georgia, Electronics Technology, Phase A, Units 35-A.
   3. Meade, Programmed Projects.
   4. Grob, Basic Electronics.

INSTRUCTIONAL MATERIALS

Tools and Equipment:

h. 10 K ohm, ½ watt resistor
i. .01 microfarad Mylar capacitor

TASK

HFM-02 Understanding fundamentals of semi-conductor materials

PERFORMANCE OBJECTIVE

Demonstrate a knowledge of the fundamentals of semi-conductor materials.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Common semi-conductor devices
b. Function of semi-conductors in electronic equipment
    1. Advantages of semi-conductors compared to vacuum tubes
    2. Disadvantages of semi-conductors compared to vacuum tubes
c. Electrical characteristics of semi-conductor materials
    1. Semi-conductor atoms
    2. Semi-conductor crystals

(Continued on back)

Provide Demonstration On:

Types of semi-conductor materials and devices

Provide Practical Application On:

Identifying the types, characteristics and applications of various semi-conductor devices

INSTRUCTIONAL MATERIALS

Textbooks:

a. Heathkit, Semi-Conductor Devices
b. Georgia, Electronics, Phase B
c. Grob, Basic Electronics

A/Vs:

Georgia, Electronics, Phase B, "Semi-Conductor Devices," slide/tape and "Semi-Conductor Materials," slide/tape

Student Manuals:

a. Georgia, Electronics, Phase B, Units 1-B and 2-B
b. Heathkit, Semi-Conductor Devices
c. Oleksy, Solid-State Electronics

Tools and Equipment:

(Continued on back)

LAB HOURS	9
CLASS HOURS	3

EVALUATION (HFM-02)

a. Given various types of semi-conductor devices, the student will identify each type, its characteritics and applications.

b. Given typical germanium and silicon diodes and the tools and equipment listed for this unit, the student will plot the V-I curves for the diodes.

c. Test and review questions can be found in:
   1. Grob, Basic Electronics.
   2. Heathkit, Semi-Conductor Devices.
   3. Georgia, Electronics, Phase B, Units 1-B and 2-B.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

d. Conduction in intrinsic germanium and silicon
   1. Low temperature characteristics
   2. High temperature characteristics
   3. Holes
   4. Current flow

e. Conduction in doped germanium and silicon
   1. N-type semi-conductors
   2. P-type semi-conductors

INSTRUCTIONAL MATERIALS

Tools and Equipment:

a. Various types of semi-conductor devices
b. Basic electricity/electronics experimenter
c. 1 silicon diode
d. 1 germanium diode
e. 1000 ohm, ½-watt resistor
f. 100 K ohm, ½-watt resistor
g. 1000 ohm potentiometer
h. VOM

TASK

HFM-03 Identifying symbols and electrical characteristics of tunnel, varactor and high frequency diodes

PERFORMANCE OBJECTIVE

Identify symbols and electrical characteristics of tunnel, varactor and high frequency diodes.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. The tunnel diode
   1. Voltage-current characteristics
   2. Negative resistance
   3. Construction and applications
   4. Tunnel diode symbols
b. The varactor diode
   1. Electrical characteristics
   2. Operating efficiency
   3. Construction and applications
   4. Varactor diode symbols
c. High frequency diodes
   1. PIN diodes
   2. IMPATT diodes
   3. Lot carrier diodes
   4. Gunn-effect diodes

Provide Demonstration On:

a. Samples of tunnel diodes, varactor diodes and high frequency diodes
b. Diode symbols

Provide Practical Application On:

a. Locating points on the V-I curve for tunnel diodes
b. Determining the quality factor (Q) for varactor diodes

INSTRUCTIONAL MATERIALS

Textbooks:

a. Heathkit, Semi-Conductor Devices
b. Georgia, Electronics, Phase B

Student Manuals:

a. Heathkit, Semi-Conductor Devices
b. Georgia, Electronics, Phase B
c. Oleksy, Solid-State Electronics
d. Zbar, Basic Electronics

Tools and Equipment:

a. Basic electricity/electronics trainer
b. Variable voltage AC power supply
c. Tunnel, varactor and high frequency diodes
d. VOM

LAB HOURS	6
CLASS HOURS	3

EVALUATION (HFM-03)

a. Given the tools and equipment listed for this unit, the student will locate the peak current, valley current, peak voltage and valley voltage points on a tunnel diode's V-I curve.

b. Given a selection of special purpose diodes, the student will identify each diode by name and their electrical characteristics and applications.

c. Test and review questions can be found in:
   1. Heathkit, Semi-Conductor Devices.
   2. Georgia, Electronics, Phase B.

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TASK

HFM-04 Understanding the fundamentals of bipolar transistors and their electrical characteristics

PERFORMANCE OBJECTIVE

Demonstrate a knowledge of the operation, construction, function, symbols for and application of bipolar transistors.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. PNP and NPN transistors and their symbols
b. Transistor construction and packaging
c. Basic transistor action
  1. Biasing NPN transistors
  2. Biasing PNP transistors
d. Transistor amplification
e. Transistor circuit arrangements
  1. Common base circuits
  2. Common emitter circuits
  3. Common collector circuits

Provide Demonstration On:

a. Types of bipolar transistors
b. Typical applications of bipolar transistors

Provide Practical Application On:

Identifying types, characteristics and applications of bipolar transistors

INSTRUCTIONAL MATERIALS

Textbooks:

a. Heathkit, Semi-Conductor Devices
b. Georgia, Electronics, Phase B
c. Abar, Basic Electronics
d. Oleksy, Solid-State Electronics

Student Manuals:

a. Heathkit, Semi-Conductor Devices
b. Georgia, Electronics, Phase B

Tools and Equipment:

Various types of bipolar transistors

LAB HOURS	3
CLASS HOURS	3

EVALUATION (HFM-04)

a. When provided with various samples of bipolar transistors, the student will correctly identify each transistor by type, electrical characteristics and applications.

b. Test and review questions can be found in:
   1. Heathkit, Semi-Conductor Devices.
   2. Georgia, Electronics, Phase B, Units 5-B, 6-B, 7-B 8-B and 9-B.

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TASK

HFM-05 Performing condition tests of bipolar transistors

PERFORMANCE OBJECTIVE

Perform condition tests of bipolar transistors.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Testing with an ohmmeter
b. Operating a transistor curve tracer
c. Operating a transistor tester
d. Testing bipolar transistors
    1. Test procedures
    2. NPN transistors testing
    3. PNP transistors testing
    4. Transistor identification

Provide Demonstration On:

Test procedures

Provide Practical Application On:

a. Using an ohmmeter
b. Operating a transistor curve tracer
c. Operating a transistor tester

INSTRUCTIONAL MATERIALS

Textbooks:

a. Heathkit, *Semi-Conductor Devices*
b. Georgia, *Electronics, Phase B*

Student Manuals:

a. Heathkit, *Semi-Conductor Devices*
b. Georgia, *Electronics, Phase B*
c. Zbar, *Basic Electronics*
d. Oleksy, *Solid-State Electronics*

Tools and Equipment:

a. Ohmmeter with test leads
b. NPN silicon transistor MPSA20
c. PNP germanium transistor 2N2431
d. Various bipolar transistor
e. Transistor curve tracer
f. Transistor tester

LAB HOURS 9

CLASS HOURS 3

EVALUATION (HFM-05)

a. Given the tools and equipment listed for this unit, the student will correctly test the transistors with an ohmmeter to determine if they are defective.

b. Test and review questions can be found in:
   1. Heathkit, Semi-Conductor Devices.
   2. Georgia, Electronics, Phase B, Unit 5.

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TASK

HFM-06 Understanding the fundamentals of field effect transistors and their electrical characteristics

PERFORMANCE OBJECTIVE

Demonstrate a knowledge of the construction, operation and electrical characteristics of field effect transistors and FET circuit arrangements.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. The function FET
    1. Construction
    2. Operation
    3. Gate-to-source cutoff voltage
    4. Pinch-off voltage
    5. Drain characteristic curves and transconductance
    6. Schematic symbols
b. The insulated gate FET
    1. Depletion-mode devices
    2. Enhancement-mode devices
    3. Safety precautions
c. FET circuit arrangement

(Continued on back)

Provide Practical Application On:

a. Characteristics and operation of a function FET
b. Characteristics and operation of an insulated gate FET

INSTRUCTIONAL MATERIALS

Textbooks:

a. Heathkit, Semi-Conductor Devices
b. Georgia, Electronics, Phase B

Student Manuals:

a. Heathkit, Semi-Conductor Devices
b. Georgia, Electronics, Phase B, Unit 12-B
c. Oleksy, Solid-State Electronics

Tools and Equipment:

a. Heathkit Electronic Design Experimenter ET-3100 or equivalent
b. Voltmeter with test leads
c. N-channel insulated gate FET
d. 2-1000 ohm, ½-watt resistors
e. 4700 ohm, ½-watt resistor
f. 10 K ohm, ½-watt resistor

(Continued on back)

LAB HOURS	3
CLASS HOURS	3

EVALUATION (HFM-06)

a. Given the tools and equipment listed for this unit, the student will design and construct an FET circuit and calculate and measure its electrical characteristics.

b. Test and review questions can be found in:
   1. Heathkit, Semi-Conductor Devices.
   2. Georgia, Electronics, Phase B.
   3. Rutkowski, Solid-State Electronics.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

1. Common-source circuits
2. Common-gate circuits
3. Common-drain circuits

INSTRUCTIONAL MATERIALS

Tools and Equipment:

g. 100 K ohm potentiometer
h. 1000 ohm potentiometer
i. N-channel junction FET
j. 100 ohm, ½-watt resistor

TASK

HFM-07 Understanding the fundamentals of thyristors and their electrical characteristics

PERFORMANCE OBJECTIVE

Demonstrate a knowledge of the electrical characteristics, construction, operation and practical applications of thyristors.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Silicon controlled rectifiers (SCR's)
  1. Construction and operation
  2. V-I characteristics
  3. Applications
b. Bidirectional triode thyristors
  1. Construction and operation
  2. V-I characteristics
  3. Applications
c. Unijunction transistors (UJT)
  1. Construction and operation
  2. V-I characteristics
  3. Applications
  4. Programmable UFT

Provide Practical Application On:

a. Operation and an application of SCR
b. Operation and an application of UJT

INSTRUCTIONAL MATERIALS

Textbooks:

a. Heathkit, Semi-Conductor Devices
b. Georgia, Electronics, Phase B

Student Manuals:

a. Heathkit, Semi-Conductor Devices
b. Georgia, Electronics, Phase B, Unit 12-B
c. Oleksy, Solid-State Electronics

Tools and Equipment:

a. Heathkit Electronic Design Experimenter ET-3100 or equivalent
b. Voltmeter with test leads
c. Silicon controlled rectifier
d. Germanium diode
e. Silicon diode
f. 220 ohm, ½-watt resistor
g. 1000 ohm, ½-watt resistor

(Continued on back)

LAB HOURS 3

CLASS HOURS 3

EVALUATION (HFM-07)

a. Given the tools and equipment listed for this unit, the student will design, construct and demonstrate the operation of an SCR in a half-wave phase control circuit.

b. Test and review questions can be found in:
   1. Georgia, Electronics, Phase B, Unit 12-B.
   2. Heathkit, Semi-Conductor Devices.
   3. Oleksy, Solid-State Electronics.

INSTRUCTIONAL MATERIALS

Tools and Equipment:

h. 4700 ohm, ½-watt resistor
i. Lamp
j. 0.1 microfarad capacitor
k. 1000 ohm potentiometer
l. 100 K ohm potentiometer
m. Unijunction transistor
n. 47 ohm, ½-watt resistor
o. 100 ohm, ½-watt resistor
p. 10 K ohm, ½-watt resistor
q. 330 K ohm, ½-watt resistor
r. 10 microfarad electrolytic capacitor
s. 1000 ohm potentiometer

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TASK

HFM-08 Understanding fundamentals of integrated circuits

PERFORMANCE OBJECTIVE

Demonstrate a knowledge of the characteritics, basic construction, modes of operation and applications of integrated circuits.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Advantages and disadvantages of IC's
b. Construction types
    1. Monolithic
    2. Bipolar
    3. MOS
    4. Thin-film
    5. Thick-film
    6. Hybrids
    7. Packages
c. Applications
    1. Tri-state gate
    2. TTL open-collector gate
    3. Decade and up/down counters

(Continued on back)

Provide Demonstration On:

Examples of integrated circuits and their applications

Provide Practical Application On:

Constructing, operating and analyzing each type of IC application

INSTRUCTIONAL MATERIALS

Textbooks:

a. Heathkit, Semi-Conductor Devices
b. Georgia, Electronics Technology, Integrated Circuits

Student Manuals:

a. Heathkit, Semi-Conductor Devices
b. Georgia, Electronics Technology, Integrated Circuits, Units IC-1 through IC-11

Tools and Equipment:

a. IC breadboarding system

(Continued on back)

LAB HOURS	9
CLASS HOURS	3

EVALUATION (HFM-08)

a. Given the tools and equipment listed for this unit, the student will construct, operate and analyze each of the following applications of IC's
   1. Tri-state gate
   2. TTL open-collector gate
   3. Decade up/down counter
   4. Multiplexes and demultiplexes
   5. Seven segment indicator and decoder
   6. Optical coupler
   7. Operational amplifier
   8. IC timer
   9. Phase-locked loop
   10. Three terminal regulator

b. Test and review questions can be found in:
   1. Heathkit, Semi-Conductor Devices.
   2. Georgia, Electronics Technology, Integrated Circuits, Student Tests.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

4. Multiplexes and demultiplexes
5. Seven segment indicators and decoders
6. Optical couplers
7. MSI applications
8. Op-amps
9. IC timers
10. Phase-locked loops
11. Three terminal regulators
12. Linear IC applications

INSTRUCTIONAL MATERIALS

Tools and Equipment:

b. Regulator - 7805
c. Potentiometer or rheostat-2.5K, 25 W
d. Oscilloscope - dual trace with DC mode
e. Sine wave generator - 0-1000 kHz with 0-10V peak-to-peak capability
f. Resistor - 4.7K ohm, 620 ohm, 3.9K, 6.8K, 1K, 100K, 10K, 300-400 ohm, 50 ohm, 1.2K, 5K, 10K, 220 ohm
g. Capacitors - 0.001 uF; 0.0047 uF; 0.1 uF; 10 uF; 0.003 uF
h. Power supply - variable voltage DC
i. Resistance decade box
j. Integrated circuit - 555
k. Miniature lamp - 8 volt
l. Diode - ECG 109
m. Switches - (2) SPST
n. Integrated circuit - uA 741; 565; 7404, 7493; 74150; 74154; 74193; 7490A, 7400, (2) 74126; (2) 7490
o. Data sheet - for uA 741 op-amp chip

INSTRUCTIONAL MATERIALS

Tools and Equipment:

p. VOM or multimeter
q. Optical coupler-motorola 4N30
r. Diode - 1N661
s. SCR - GE C20D
t. Transformer - 12.6V filament type
u. Digital clock
v. BCD to decimal decoder - 7447
w. Program switches
x. State indicator lights - 6
y. Clock-for 5 volt system with both manual and low frequency capability
z. LED - 1.6V; 20 mA
aa. Interconnecting leads
bb. Function generator
cc. Hand tools- wirestripper and long-nosed pliers

TASK

HFM-09 Defining the operating values and applications of optoelectronic devices

PERFORMANCE OBJECTIVE

Demonstrate a knowledge of the principles of operation and the practical applications of optoelectronic devices.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Characteristics of light
b. Systems of light measurement
    1. Radiometric
    2. Photometric
c. Light sensitive devices
    1. Photoconductive cells
    2. Photovoltanic cells
    3. Photodiodes
    4. Phototransistors
d. Light emitting devices
    1. Operation and construction
    2. Electrical characteristics
    3. Applications

Provide Practical Application On:

a. Operating a phototransistor
b. Operating a LED

INSTRUCTIONAL MATERIALS

Textbooks:

a. Heathkit, Semi-Conductor Devices
b. Georgia, Electronics Technology, Integrated Circuits

Student Manuals:

a. Heathkit, Semi-Conductor Devices
b. Georgia, Electronics Technology, Integrated Circuits

Tools and Equipment:

a. Heathkit Electronic Design Experimenter ET-3100 or equivalent
b. Volt-ohm meter with test leads
c. Phototransistor
d. Lamp
e. 10 K ohm, ½-watt
f. 1000 K ohm potentiometer (built into ET-3100)

(Continued on back)

LAB HOURS	3
CLASS HOURS	3

EVALUATION (HFM-09)

a. Given the tools and equipment listed for this unit, the student will demonstrate the operation of
   1. A phototransistor
   2. A light-emitting diode

b. Test and review questions can be found in:
   1. Heathkit, Semi-Conductor Devices.
   2. Georgia, Electronics Technology, Integrated Circuits, Student Tests.

INSTRUCTIONAL MATERIALS

Tools and Equipment:

g. LED
h. 1000 K ohm, ½-watt

TASK

HFM-10 Identifying the component parts and operational characteristics of diode vacuum tubes

PERFORMANCE OBJECTIVE

Identify the component parts and operational characteristics of diode vacuum tubes.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Construction of diode vacuum tubes
b. Thermionic emission
c. Cathode construction
d. Filament current
e. The vacuum
f. Diode rectifier circuits
    1. Load resistance
    2. Half-wave rectifier
    3. Ripple frequency
    4. DC polarity
    5. The diode as a one-way switch
g. Schematic symbol

Provide Demonstration On:

a. Various types of diode vacuum tubes
b. Diode vacuum tube applications

Provide Practical Application On:

Operation and dynamic characteristics of diode vacuum tubes

INSTRUCTIONAL MATERIALS

Textbooks:

a. Grob, Basic Electronics
b. Manufacturer's tube manual
c. Georgia, Electronics, Phase B
d. Training and Retraining, Inc., Basic Electricity/Electronics

Student Manuals:

Georgia, Electronics, Phase B, Unit 13-B

Tools and Equipment:

a. Variable power supply panel
b. Vacuum tube characteristics panel
c. Multimeter
d. Oscilloscope
e. Linear graph paper
f. 100,000 ohm, 1-watt resistor
g. 22,000 ohm, 1-watt resistor

(Continued on back)

LAB HOURS 3
CLASS HOURS 3

EVALUATION (HFM-10)

a. Given the tools and equipment listed for this unit, the student will demonstrate the operation and operational characteristics of diode vacuum tubes.

b. Test and review questions can be found in:
   1. Grob, Basic Electronics.
   2. Georgia, Electronics, Phase B, Unit 13-B.
   3. Training and Retraining, Inc., Basic Electricity/ Electronics.

INSTRUCTIONAL MATERIALS

Tools and Equipment:

h. Vacuum tube, type 6AL5
i. Diode schematic overlay

TASK

HFM-11 Identifying the component parts and operating characteristics of triode vacuum tubes

PERFORMANCE OBJECTIVE

Demonstrate a knowledge of the characteristics and operation of triode vacuum tubes and the ability to identify the parts of a triode vacuum tube.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Triode construction
b. C-voltage
c. Grid cutoff voltage
d. Triode circuit
e. Control-grid bias
f. Symbols for tube voltages
g. How a triode amplifies the control grid voltage
    1. Phase inversion
    2. Voltage gain
h. Triode characteristic values of grid voltage
i. Tube parameters
    1. Amplification factor
    2. Plate resistance
    3. Transconductance

(Continued on back)

Provide Demonstration On:

a. Various types of triode vacuum tubes
b. Triode vacuum tube application

Provide Practical Application On:

a. Identifying static characteristics of triode vacuum tubes
b. Producing triode vacuum tube bias
c. Using the triode vacuum tube as an amplifier

INSTRUCTIONAL MATERIALS

Textbooks:

a. Grob, Basic Electronics
b. Manufacturer's tube manual
c. Georgia, Electronics, Phase B
d. Training and Retraining, Inc., Basic Electricity/Electronics

Student Manuals:

Georgia, Electronics, Phase B, Units 13-B and 14-B

Tools and Equipment:

a. Typical triode static characteristics curves
b. Linear graph paper
c. Variable power supply panel
d. Vacuum tube characteristics panel
e. Vacuum tube, type 6J5
f. Triode schematic overlay
g. Vacuum-tube voltmeter

(Continued on back)

LAB HOURS	3
CLASS HOURS	3

EVALUATION (HFM-11)

a. Given the tools and equipment listed for this unit, the student will demonstrate the operation and operational characteristics of triode vacuum tubes.

b. Test and review questions can be found in:
   1. Grob, Basic Electronics.
   2. Georgia, Electronics, Phase B, Units 13-B and 14-B.
   3. Training and Retraining, Inc., Basic Electricity/Electronics.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

j. Tube manuals
k. Biasing
l. Interelectrode capacitance
m. Feedback voltage

INSTRUCTIONAL MATERIALS

Tools and Equipment:

h. Audio-frequency signal
i. Oscilloscope
j. 1 megohm, 1-watt resistor
k. 470,000 ohm, 1-watt resistor
l. 5100 ohm, 7-watt resistor
m. 1000 ohm, 1-watt resistor
n. .1 microfarad capacitor
o. .2 microfarad capacitor
p. 47,000 ohm 1-watt resistor
q. 2200 ohm, 1-watt resistor

TASK

HFM-12 Identifying the component parts and operating characteristics of tetrode vacuum tubes

PERFORMANCE OBJECTIVE

Identify the component parts and operating characteristics of tetrode vacuum tubes.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Tetrode tube construction
   1. Feedback reduction
   2. The screen grid
b. Screen grid voltage
c. Screen bypass capacitor
d. Grid plate capacitance
e. Secondary emission

Provide Demonstration On:

a. Types of terode vacuum tubes
b. Tetrode vacuum tube applications

Provide Practical Application On:

Operation and static characteristics of tetrode vacuum tubes

INSTRUCTIONAL MATERIALS

Textbooks:

a. Grob, Basic Electronics
b. Manufacturer's tube manual
c. Training and Retraining, Inc., Basic Electricity/Electronics

Tools and Equipment:

a. Variable power supply panel
b. Vacuum tube characteristics panel
c. Linear graph paper
d. Vacuum tube, type 6SJ7
e. 1000 ohm, 5-watt resistor
f. 27 ohm, 1-watt resistor
g. Vacuum-tube voltmeter

LAB HOURS	3
CLASS HOURS	3

EVALUATION (HFM-12)

a. Given the tools and equipment listed for this unit, the student will demonstrate the operation and operational characteristics of tetrode vacuum tubes.

b. Test and review questions can be found in:
   1. Grob, Basic Electronics.
   2. Training and Retraining, Inc., Basic Electricty/ Electronics.

TASK

HFM-13 Identifying the component parts and operating characteristics of pentode vacuum tubes

PERFORMANCE OBJECTIVE

Identify the component parts and operating characteristics of pentode vacuum tubes.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Pentode tube construction
b. Pentode vacuum tube characteristics
c. Current paths
d. Remote cutoff pentodes
e. High frequency operation
f. Secondary emission
g. Suppressor grid

Provide Demonstration On:

a. Types of pentode tubes
b. Pentode tube application

Provide Practical Application On:

Operation and static characteristics of a pentode vacuum tube

INSTRUCTIONAL MATERIALS

Textbooks:

a. Grob, Basic Electronics
b. Manufacturer's tube manual
c. Training and Retraining, Inc., Basic Electricity/Electronics

Tools and Equipment:

a. Variable power supply panel
b. Vacuum tube characteristics panel
c. Linear graph paper
d. Vacuum tube, type 6SJ7
e. 1000 ohm, 5-watt resistor
f. 27 ohm, 1-watt resistor

LAB HOURS	3
CLASS HOURS	3

EVALUATION (HFM-13)

a. Given the tools and equipment listed for this unit, the student will demonstrate the operation and operational characteristics of pentode vacuum tubes.

b. Test and review questions can be found in:
   1. Grob, Basic Electronics.
   2. Training and Retraining, Inc., Basic Electricity/Electronics.

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TASK

HFM-14 Performing condition testing of the thermal stability and operational parameters of a common-emitter amplifier circuit

PERFORMANCE OBJECTIVE

Determine the thermal stability and operational parameters of a common-emitter amplifier circuit.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

- a. Function and types of amplifiers
- b. Amplifier configurations
  - 1. Common-emitter circuits
  - 2. Common-base circuits
  - 3. Common-collector circuits
- c. Amplifier biasing
  - 1. Base-biased circuits
  - 2. Feedback bias
  - 3. Voltage-divider biasing
  - 4. Class of operation
- d. Amplifier coupling
  - 1. Resistance-capacitance coupling

(Continued on back)

Provide Demonstration On:

- a. Thermal stability of basic amplifier circuits
- b. Operation and characteristics of a common-emitter amplifier circuit

Provide Practical Application On:

- a. A basic amplifier circuit and demonstrate the relative thermal stability
- b. A common-emitter amplifier and determine

INSTRUCTIONAL MATERIALS

Textbooks:

- a. Heathkit, Electronic Circuits
- b. Grob, Basic Electronics
- c. Shrader, Electronic Communications

Student Manuals:

- a. Heathkit, Electronic Circuits, Student Workbook
- b. Georgia, Electronics, Phase B

Tools and Equipment:

- a. Heathkit Electronic Design Experimenter (ET-3100 or equivalent)

(Continued on back)

LAB HOURS 9

CLASS HOURS 3

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EVALUATION (HFM-14)

a. Given a common-emitter amplifier circuit and the necessary supplies and equipment, the student will determine the thermal stability and operational parameter of the circuit. Test results must be within specifications established by the instructor.

b. Test and review questions can be found in:
   1. Heathkit, Electronic Circuits, Student Workbook.
   2. Georgia, Electronics, Phase B.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

2. Impedance coupling
3. Direct coupling
4. Transformer coupling

INSTRUCTIONAL MATERIALS

Tools and Equipment:

b. Voltmeter
c. NPN transistor
d. 2.2 kilohm, ½-watt resistor
e. 4.7 kilohm, ½-watt resistor
f. Two 10 kilohm, ½-watt resistor
g. 22 kilohm, ½-watt resistor
h. 470 kilohm, ½-watt resistor
i. 1.5 megohm potentiometer
j. Multimeter with leads
k. Oscilloscope
l. 1 kilohm, ½-watt resistor
m. 56 kilohm, ½-watt resistor
n. Three 33 microfarad tantalum capacitors
o. 1 kilohm potentiometer (built into ET-3100)
p. 100 kilohm potentiometer (built into ET-3100)

TASK

HFM-15 Performing condition testing of DC and audio amplifiers

PERFORMANCE OBJECTIVE

Determine the condition of DC and audio amplifiers.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Direct current amplifiers
   1. Multiple-stage amplifiers
   2. Darlington amplifiers
   3. Differential amplifiers
b. Audio amplifiers
   1. Voltage amplifiers
   2. Power amplifiers
   3. Single-ended power amplifiers
   4. Push-pull power amplifiers
   5. Complementary amplifiers

(Continued on back)

Provide Demonstration On:

a. The DC amplifier
b. Distortion in a complementary power amplifier

Provide Practical Application On:

Condition testing of DC and audio amplifiers

INSTRUCTIONAL MATERIALS

Textbooks:

a. Heathkit, Electronic Circuits
b. Grob, Basic Electronics
c. Shrader, Electronic Communications

Student Manuals:

a. Heathkit, Electronic Circuits, Student Workbook
b. Georgia, Electronics, Phase B

Tools and Equipment:

a. Heathkit Experimenter (ET-3100 or equivalent)
b. Multimeter with leads

(Continued on back)

LAB HOURS 9

CLASS HOURS 3

EVALUATION (HFM-15)

a. Given DC and audio amplifiers and the necessary supplies and equipment, the student will determine the condition of the amplifiers. Test results must be within specifications established by the instructor.

b. Test and review questions can be found in:
   1. Heathkit, Electronic Circuits, Student Workbook, Unit 2.
   2. Georgia, Electronics, Phase B.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

6. Quasi-complementary amplifiers
7. Heat sinks
8. Volume control circuits
9. Tone control circuits

INSTRUCTIONAL MATERIALS

Tools and Equipment:

c. Calibrated oscilloscope with leads
d. 4.7 ohm, ½-watt resistor
e. Two 100 ohm, ½-watt resistors
f. Two 330 ohm, ½-watt resistors
g. 4700 ohm, ½-watt resistor
h. 8200 ohm, ½-watt resistor
i. 10 kilohm, ½-watt resistor
j. 47 kilohm, ½-watt resistor
k. 10 microfarad tantalum capacitor
l. 33 microfarad electrolytic capacitor
m. 250 microfarad electrolytic capacitor
n. 100 microfarad electrolytic capacitor
o. 0.1 microfarad Mylar
p. Stabistor
q. Two NPN transistors
r. PNP transistor
s. Loudspeaker
t. One kilohm potentiometer (built into ET-3100)
u. Two 1000 ohm, ½-watt resistors
v. 100 kilohm, ½-watt resistors
w. 100 pF capacitor
x. 1000 pF (.001 microfarad)
y. Silicon diode
z. Darlington transistor

TASK

HFM-16 Defining electrical characteristics, applications and normal operational values of amplifiers

PERFORMANCE OBJECTIVE

Determine electrical characteristics, applications and normal operational values of amplifiers.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Differential amplifiers
   1. Basic differential amplifier circuits
   2. Single-input, single output operation
   3. Single input, differential-output circuit
   4. Differential-input, differential-output operation
   5. Current sources and voltage sources
   6. Practical current
   7. Practical differential amplifiers
   8. Common-mode input operation

(Continued on back)

Provide Demonstration On:

Operational amplifiers

Provide Practical Application On:

a. Determining characteristics of differential amplifiers
b. Determining characteristics of the operational amplifier and its use as a comparator
c. Determining characteristics of inverting and non-inverting amplifiers
d. Determining characteristics of active filters

INSTRUCTIONAL MATERIALS

Textbooks:

a. Heathkit, Electronic Circuits
b. Grob, Basic Electronics
c. Schrader, Electronic Communication

Student Manuals:

a. Heathkit, Electronic Circuits, Student Workbook
b. Georgia, Electronics, Phase B

Tools and Equipment:

a. Heathkit Experimenter (ET-3100 or equivalent)
b. Multimeter with leads

(Continued on back)

LAB HOURS	3
CLASS HOURS	3

EVALUATION (HFM-16)

a. Given amplifier(s) and the necessary supplies and equipment, the student will determine the electrical characteristics, applications and normal operational values of the amplifier. The test results must be within the limits of the actual values of the amplifier and the applications must be identified.

b. Test and review questions can be found in:
   1. Heathkit, Electronic Circuits, Student Workbook, Unit 2.
   2. Georgia, Electronics, Phase B.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

9. Differential-input operation
10. Common-mode rejection ratio
11. IC differential amplifiers
b. Operational amplifier characteristics
c. LC operational amplifier families
d. Closed-loop operation
   1. Inverting configuration
   2. Noninverting configuration
   3. Bandwidth limitations
   4. Operational amplifier circuits
e. Applications of operational amplifiers
   1. Summing amplifier (adder)
   2. Active filters
   3. Difference amplifiers

INSTRUCTIONAL MATERIALS

Tools and Equipment:

c. Oscilloscope with probe
d. 100 K ohm, potentiometer (built into ET-3100
e. 10 ohm, ½-watt resistor
f. Three NPN transistors
g. Two 4.7 K ohm, ½-watt resistor
h. Two 10 K ohm ½-watt resistor
i. 2.2 K ohm ½-watt resistor
j. 33 K ohm, ½-watt resistor
k. 47 K ohm, ½-watt resistor
l. Three 1 K ohm ½-watt resistors
m. Two 100 ohm, ½-watt resistors
n. 200 ohm, potentiometer
o. Audio transformer
p. 10 microfarad electrolytic capacitor
q. 1 K ohm potentiometer (built into ET-3100)
r. Hook-up wire
s. Soldering iron
t. 741 C operational amplifier
u. Two 100 K ohm, ½-watt resistors
v. Three 0.0022 microfarad capacitors
w. 8.2 K ohm, ½-watt resistor

TASK

EES-01 Performing a visual inspection of electronic equipment

PERFORMANCE OBJECTIVE

Perform a visual inspection on a piece of electronic equipment and identify any abnormal conditions.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. How to inspect equipment for physical damage (rough handling)
b. How to identify possible danger signs
    1. Circuit overheat
    2. Cracked insulation
    3. Dust and dirt
    4. Fatigue fractures
    5. Loose lock nuts, set screws
    6. Evidence of arcing
    7. Broken wiring
    8. Broken components

Provide Demonstration On:

a. Inspecting equipment for physical damage
b. Identifying possible danger signals

Provide Practical Application On:

a. Inspecting equipment for physical damage
b. Identifying possible danger signals

INSTRUCTIONAL MATERIALS

Textbooks:

Equipment service manuals

Tools and Equipment:

a. Screwdrivers
b. Inspection manual
c. Inspection probe (non-conductive)
d. Flashlight
e. Compressed air
f. Goggles/safety glasses
g. Checklist

LAB HOURS	6
CLASS HOURS	4

EVALUATION (EES-01)

Given guidelines, tools and supplies for performing a visual inspection of known equipment, the student will perform a visual inspection and record condition of equipment on appropriate checklist.

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TASK

EES-02 Cleaning electronic equipment

PERFORMANCE OBJECTIVE

Clean a piece of electronic equipment to required standards.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Cleaning standards
   1. Exterior (cabinets)
   2. Interior (chassis)
   3. Operator controls
   4. "Dirt free" components/areas
   5. Face of CRT
   6. Movable hardware
b. Types of cleaning supplies
   1. Compressed air
   2. Solvents
   3. Water
   4. Brushes (various)
   5. Paper towels
   6. Cloth rags
   7. Anti-static solution
   8. Cotton swabs
   9. Lens tissue

Provide Demonstration On:

Cleaning electronic equipment

Provide Practical Application On:

Cleaning electronic equipment

INSTRUCTIONAL MATERIALS

Textbooks:

a. Equipment service manuals
b. Solvent specifications

Tools and Equipment:

a. Screwdrivers
b. Inspection mirror
c. Inspection probe (non-conductive)
d. Inspection light
e. Compressed air
f. Goggles/safety glasses
g. Checklist
h. Solvents
i. Water

(Continued on back)

LAB HOURS	8
CLASS HOURS	4

EVALUATION (EES-02)

a. Given equipment, tools and supplies, the student will clean an item of electronic equipment to required standards and record steps taken on a checklist. Equipment must meet standards demonstrated by the instructor or stated on the checklist.

b. V'TECS, Electronics Mechanics, Task Nos. E-02 - E-13.

c. V'TECS, Radio-Television, Task No. 159.

d. V'TECS, Radio Communications Technician, Task Nos. 22 and 43.

INSTRUCTIONAL MATERIALS

Tools and Equipment:

j. Brushes
k. Paper towels
l. Cloth rags
m. Anti-static solution
n. Cotton swabs

TASK

EES-03 Lubricating electronic equipment

PERFORMANCE OBJECTIVE

Lubricate a piece of electronic equipment to required standards.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Types of lubricants
    1. Non-conductive
    2. Conductive
    3. For high heat areas
    4. By viscosity rating
b. Types of materials lubricants used on
    1. Metals
    2. Plastics
    3. Plant fiber
    4. Carbon surface
c. Tools for application
    1. Oilers (various).
    2. Drop tube (straw)
    3. Paddles
    4. Probes
    5. Pads
    6. Tubes of grease

Provide Demonstration On:

Lubricating electronic equipment

Provide Practical Application On:

Lubricating electronic equipment

INSTRUCTIONAL MATERIALS

Textbooks:

a. Equipment service manuals
b. Lubricant specifications

Tools and Equipment:

a. Handtools
b. Inspection mirror
c. Inspection probe (non-conductive)
d. Inspection light
e. Checklist
f. Oilers (various)
g. Drop tube (straw)
h. Paddles (various sizes)
i. Probes
j. Cloth rags

(Continued on back)

LAB HOURS 3

CLASS HOURS 3

EVALUATION (EES-03)

a. Given equipment, tools and supplies, the student will lubricate an item of electronic equipment to required standards and record steps taken on a checklist. Equipment must meet standards demonstrated by the instructor or stated on the checklist.

b. V'TECS, Radio-Television, Task No. 56.

INSTRUCTIONAL MATERIALS

Tools and Equipment:

k. Cleaning pads
l. Tubes of grease

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TASK

EES-04 Inspecting and replacing power cords and distribution cables

PERFORMANCE OBJECTIVE

Inspect and replace power cords and distribution cables.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Materials used
    1. Cords
    2. Cables
    3. Cable ties
    4. Clamps
    5. Connectors
    6. Lacing
b. Assembly methods
c. Possible damage
    1. Physical abuse
    2. Electrical overload
d. Visual inspections
e. Testing with instruments
    1. VOM
    2. Reflectometer

Provide Demonstration On:

a. Cords and cable sets
b. Referencing standards and recording maintenance actions
c. Performing condition test

Provide Practical Application On:

a. Performing condition tests
b. Referencing standards and recording maintenance actions

INSTRUCTIONAL MATERIALS

Textbooks:

a. Duarte, Electronics Assembly and Fabrication Methods
b. Equipment service manual
c. Test equipment operation manual
d. Parts catalogs

Tools and Equipment:

a. Screwdrivers
b. Wrenches
c. Soldering iron
d. Solder
e. Pliers
f. Flashlight
g. Solder remover
h. VOM
i. Reflectometer
j. Cord and/or wiring

LAB HOURS	6
CLASS HOURS	3

EVALUATION (EES-04)

a. Given power cords, distribution cables, tools, supplies and test instruments, the student will inspect and repair cords and cables to required standards, as either demonstrated by the instructor or stated on the checklist.

b. V'TECS, Electronics Mechanics, Task No. E-19.

c. V'TECS, Radio Communications Technician, Task No. 19.

TASK

EES-05 Inspecting and replacing vacuum tubes

PERFORMANCE OBJECTIVE

Inspect and replace vacuum tubes which are component parts of electronic equipment.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Removal and installation of vacuum tubes
b. Operation of tube testers
c. Procedures for testing a specific vacuum tube
d. Control of defective tubes (methods of discarding which observe environmental protection requirements)
e. Signal tracing and condition testing

Provide Demonstration On:

a. Signal tracing through tube of operating equipment with oscilloscope
b. Voltage measuring tube using EVM
c. Removing and inspecting tubes
d. Testing tube on tube tester
e. Procedures for control of defective tubes

Provide Practical Application On:

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

a. Equipment service manual
b. Tube manuals
c. Applicable legal restrictions
d. Parts catalogs
e. Tube tester operation manual

Tools and Equipment:

a. Tube
b. Screwdrivers
c. Pliers
d. Wrenches
e. Tube tester
f. EVM
g. Oscilloscope
h. Times 1 probe
i. Times 10 probe

LAB HOURS	6
CLASS HOURS	3

EVALUATION (EES-05)

a. Given equipment, tools, supplies and test instruments, the student will correctly locate defective tube and replace it. Voltage tests and wave form analysis will be used to determine defective tube and verify normal operation after tube is replaced.

b. V'TECS, Electronics Mechanics, Task No. F-45.

c. V'TECS, Radio-Television, Task No. 26.

d. V'TECS, Radio Communications Technician, Task No. 37.

INSTRUCTIONAL ACTIVITIES

Provide Practical Application On:

a. Signal tracing tubes with oscilloscope
b. Using EVM to measure voltage
c. Removing and inspecting tubes
d. Testing tubes

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TASK

EES-06 Inspecting and replacing transistors

PERFORMANCE OBJECTIVE

Inspect transistors using VOM, EVM, oscilloscope and transistor tester and replace those found to be defective.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Gaining access to circuit with transistor
b. Visual inspection
c. In-circuit testing
    1. Live circuit
    2. Circuit de-energized
d. Removal of defective transistor
e. Condition test using transistor tester
f. Replacing transistors
g. Cautions
    1. Connector tab alignment during replacement
    2. If soldering required, avoid solder bridges between connectors and avoid excessive heat

Provide Demonstration On:

a. Equipment having transistors mounted in sockets
b. Equipment having transistors with leads soldered
c. Procedures for inspecting transistors
d. Techniques of removal and replacement

Provide Practical Application On:

a. Inspecting transistors
b. Removing and replacing transistors

INSTRUCTIONAL MATERIALS

Textbooks:

a. Transistor manuals
b. Equipment service manuals
c. Parts catalogs
d. Transistor tester operation manual

Tools and Equipment:

a. Screwdrivers
b. Wrenches
c. Soldering iron
d. Solder
e. Pliers
f. Flashlight
g. Transistor
h. VOM
i. Oscilloscope
j. EVM

LAB HOURS	9
CLASS HOURS	3

EVALUATION (EES-06)

a. Given equipment, tools, supplies, test instruments and references, the student will accurately locate and replace the defective transistor. Voltage tests and wave form analysis will be used to determine fault and verify normal operation after replacement.

b. V'TECS, Electronic Mechanics, Task No. F-43.

c. V'TECS, Radio-Television, Task No. 23.

d. V'TECS, Radio Communications Technician, Task No. 34.

500

TASK

EES-07 Inspecting and replacing IC units

PERFORMANCE OBJECTIVE

Inspect and replace IC units.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Typical IC units
b. Circuit IC units
c. How to remove and replace the IC unit
    1. Access to IC unit
    2. Installation of heat sinks
    3. Desoldering defective IC units
    4. Removal of excess solder and resin
    5. Installing replacement IC
    6. Installing heat sinks
    7. Checking that solder bridges do not exist

(Continued on back)

Provide Demonstration On:

a. Normal in-circuit voltage and resistance for IC units
b. How to compare measured results with normal range and determine defective IC
c. Procedure for removal and replacement
d. Operational check to conform equipment meets specifications

Provide Practical Application On:

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

a. IC data manuals
b. Equipment service manuals
c. Parts catalogs
d. Test instrument operation manuals

Tools and Equipment:

a. Screwdrivers
b. Soldering iron
c. Pliers
d. Solvent
e. Solder
f. Heat sinks
g. Wire brush
h. IC units
i. VOM
j. Oscilloscope

LAB HOURS	9
CLASS HOURS	3

50

EVALUATION (ESS-07)

a. Given equipment, tools, supplies, test instruments and references, the student will locate a defective IC unit and replace it. Voltage, resistance and wave form analysis will be used to determine the defective IC unit and verify normal operation after IC unit is replaced.

b. V'TECS, Electronics Mechanics, Task No. F-15.

c. V'TECS, Radio Communications Technician, Task No. 40.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

8. Removing excess solder
9. Removing heat sinks
10. Removing excess resin

Provide Practical Application On:

a. Checking voltage and resistance at reference points
b. Analyzing measurements to locate faulty component
c. Removal and replacement of IC units

502

TASK

EES-08 Inspecting and replacing printed circuit (PC) boards

PERFORMANCE OBJECTIVE

Inspect and replace printed circuit (PC) boards.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Types of PC boards
b. Usual faults of PC boards
c. Procedure for locating a fault
d. Decision to repair or replace PC board
e. Techniques used when repairing or replacing PC boards

Provide Demonstration On:

a. Techniques of visual inspection of PC boards
b. Techniques of fault finding using an ohmmeter
c. Procedure for repair and replacement of PC boards

Provide Practical Application On:

a. Locating defective portions of PC board
b. Using visual and ohmmeter inspection techniques
c. Repairing and replacing PC boards

INSTRUCTIONAL MATERIALS

Textbooks:

a. Equipment service manuals
b. Parts catalogs

Tools and Equipment:

a. Screwdrivers
b. Wrenches
c. Soldering iron
d. Solder
e. Flashlight
f. Magnifying glass
g. PC boards
h. VOM

LAB HOURS	9
CLASS HOURS	3

EVALUATION (EES-08)

a. Given equipment, tools supplies, test instrument and references, the student will locate defective portion(s) of a PC board and repair or replace as necessary. Repaired or replaced action must maintain equipment specifications.

b. V'TECS, Electronics Mechanics, Task No. F24.

c. V'TECS, Radio-Television, Task No. 18.

d. V'TECS, Radio Communications Technician, Task Nos. 30 and 32.

504

TASK

EES-09 Performing a proof of performance on electronic equipment

PERFORMANCE OBJECTIVE

Perform visual and instrument checks for verifying equipment operating within range of specified tolerances.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Written guidelines to do proof testing
b. Selection of test instruments
c. Guidelines for assembling a test configuration
d. Minimum test required for proofing
e. Recording test results

Provide Demonstration On:

a. Components of sub-assemblies
b. Conducting a proof of performance test

Provide Practical Application On:

Performing a proof of performance test

INSTRUCTIONAL MATERIALS

Textbooks:

a. Equipment service manuals
b. Schuster, Logical Electronic Troubleshooting

LAB HOURS	9
CLASS HOURS	3

EVALUATION (EES-09)

a. Given guidelines for performing a proof of performance, test instruments and tools, the student will determine if results indicate operating characteristics that conform to equipment specifications.

b. V'TECS, Electronic Mechanics, Task Nos. D2-D7.

c. V'TECS, Radio-Television, Task Nos. 157 and 186.

d. V'TECS, Radio Communications Technician, Task Nos. 44-73.

TASK

EES-10 Keeping records on maintenance of equipment

PERFORMANCE OBJECTIVE

Record and file the record of maintenance actions performed on electronic equipment.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Guidelines for record keeping
b. Selection of significant information for recording
c. Administrative procedures for storage and retrieval of records
d. Guidelines for discarding records

Provide Demonstration On:

a. Using guidelines to select significant information
b. Method of record keeping
c. Disposal procedures

Provide Practical Application On:

a. Gathering significant data for recording
b. Making entries reflecting maintenance actions on past tasks
c. Establishing a disposal data

INSTRUCTIONAL MATERIALS

Tools and Equipment:

a. Guidelines for record-keeping
b. Record log
c. Data for tasks selected by instructor

LAB HOURS 9

CLASS HOURS 3

EVALUATION (EES-10)

a. Given guidelines and data of past maintenance actions, the student will prepare a record of significant maintenance information and establish a date for disposal.

b. V'TECS, Electronic Mechanics, Task No. C24.

c. V'TECS, Radio-Television, Task No. 175.

d. V'TECS, Radio Communications Technician, Task No. 72.

508

TASK

DCT-01 Determining meter movement, sensitivity and resistance

PERFORMANCE OBJECTIVE

Determine meter movement, sensitivity and resistance.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Internal resistance of a meter movement
b. Full scale current deflection

Provide Demonstration On:

a. Full deflection current
b. Using a shunt resistor to reduce the current to one half so the shunt equals the meter resistance
c. Using Ohm's law to calculate meter resistance

Provide Practical Application On:

a. Measuring full scale current and the meter voltage drop on several measurements
b. Calculating "R" internal

INSTRUCTIONAL MATERIALS

Textbooks:

Zbar, *Basic Electricity*

Tools and Equipment:

a. Meter movements
b. Current circuit with variable voltage

LAB HOURS	4
CLASS HOURS	2

EVALUATION (DCT-01)

Given a meter movement and necessary test equipment and circuit, the student will correctly measure the internal resistance and full scale current sensitivity of the meter movement.

TASK

DCT-02 Extending the current range of a meter movement

PERFORMANCE OBJECTIVE

Extend the current range of a meter movement.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Meter internal resistance
b. Meter full scale current range
c. Current divider theory
d. Excess current shuntime

Provide Demonstration On:

a. How the basic current meter circuit is built
b. How a current shunt is added to pass excessive current around the meter
c. How current shunt is calculated to provide current range desired

Provide Practical Application On:

Wiring a simple current meter and then calculating a shunt that can be added to extend the current range to a required value

INSTRUCTIONAL MATERIALS

Textbooks:

Zbar, Basic Electricity

Tools and Equipment:

a. Power supply, variable
b. Current needed
c. Test circuit
d. Variable shunts

LAB HOURS	4
CLASS HOURS	2

EVALUATION (DCT-02)

Given a current meter of known specifications, the student will calculate and add to the basic current meter a shunt that will extend the basic current meter circuit to an increased specified current range.

512

TASK

DCT-03 Extending the voltage range of a meter movement

PERFORMANCE OBJECTIVE

Extend the voltage range of a meter movement.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Meter internal resistance
b. Meter full-scale deflection
c. Series circuit action
d. Increased voltage requires increased circuit resistance

Provide Demonstration On:

a. Basic voltmeter circuits
b. How multiplier resistors can be switched in to change voltmeter range
c. How to calculate a multiplier resistor for a specific range

Provide Practical Application On:

a. Wiring a basic voltmeter
b. Calculating the multiplier resistors for different voltage ranges

INSTRUCTIONAL MATERIALS

Textbooks:

Zbar, Basic Electricity

Tools and Equipment:

a. Power supply, variable
b. Meter movement with known full-scale current and internal resistance
c. Variable resistors

LAB HOURS	4
CLASS HOURS	2

EVALUATION (DCT-03)

Given a meter with known internal resistance and full-scale deflection values, the student will calculate and design extended voltmeter range multipliers to meet voltage ranges given by the instructor.

TASK

DCT-04 Performing a condition test of a semi-conductor diode using an ohmmeter

PERFORMANCE OBJECTIVE

Perform a condition test of a semi-conductor diode.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. The PN junction
b. Diode biasing
   1. Forward bias
   2. Reverse bias
c. Diode characteristics
   1. Germanium diode
   2. Silicon diode
   3. Diode ratings
   4. Effect of temperature
   5. Diode symbols
d. Diode construction
   1. Diode construction
   2. Alloyed junctions
   3. Diffused junctions
   4. Diode packaging
e. Rectification and other applications

Provide Practical Application On:

a. Semi-conductor diode characteristics
b. Testing semi-conductor diodes

INSTRUCTIONAL MATERIALS

Textbooks:

a. Heathkit, Semi-Conductor Devices
b. Georgia, Electronics, Phase B
c. Zbar, Basic Electricity

Student Manuals:

a. Georgia, Electronics, Phase B, Unit 3-B
b. Heathkit, Semi-Conductor Devices
c. Oleksy, Solid-State Electronics
d. Zbar, Basic Electricity

Tools and Equipment:

a. Heathkit Electronic Design Experimenter ET-3100 or equivalent
b. Ohmmeter with test leads
c. Voltmeter with test leads
d. Silicon diode
e. Germanium diode
f. 1000 ohm, ½-watt resistor
g. 100 ohm, ½-watt resistor
h. 1000 ohm potentiometer

LAB HOURS	3
CLASS HOURS	3

EVALUATION (DCT-04)

a. Given a germanium diode, a silicon diode and an ohmmeter, the student will test the condition of the diodes to determine if they are good or bad.

b. Test and review questions can be found in:
   1. Georgia, Electronics, Phase B, Unit 3-B.
   2. Heathkit, Semi-Conductor Devices.

516

TASK

LFT-01 Testing an amplifier for amplification

PERFORMANCE OBJECTIVE

Test and determine the amplification gain of an amplifier.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Amplifier operation and theory
b. Test equipment hook-up for testing
c. Gain measurement test

Provide Demonstration On:

a. How to set up an amplifier to perform gain test
b. How to collect data from gain test
c. How to plot an amplifier amplitude to frequency gain characteristic

Provide Practical Application On:

a. Testing amplifiers for gain characteristics and collecting data that can be used to plot the amplifiers gain parameters
b. Plotting the gain characteristics of the amplifiers

INSTRUCTIONAL MATERIALS

Textbooks:

Wells, Audio Servicing: Theory and Practice

Student Manuals:

a. Wells, Audio Servicing: A Text-Lab Manual
b. Georgia, Electronics, Phase B

Tools and Equipment:

a. Amplifiers
b. Voltmeter
c. Oscilloscope
d. Audio meter
e. Graph paper

LAB HOURS	3
CLASS HOURS	3

EVALUATION (LFT-01)

Given an amplifier and the necessary supplies and equipment, the student will test, collect data and plot the gain of the amplifier. The data must be plotted on graph paper so that an overall picture of the characteristics (amplitude to frequency response) can be seen. The characteristics must be within the operational parameter of the amplifier.

513

TASK

LFT-02 Testing and repairing the vacuum tube amplifier

PERFORMANCE OBJECTIVE

Test and repair the vacuum tube amplifier.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Normal operating procedure of the vacuum tube amplifier
b. Troubleshooting steps
c. Standard repair procedures

Provide Demonstration On:

a. Testing the amplifier for normal performance
b. Some abnormal operating conditions of the amplifier
c. The standard method to troubleshoot the amplifier

Provide Practical Application On:

a. Practicing checking out vacuum tube amplifiers for normal operation
b. Demonstrating how to correct malfunctions in the vacuum tube amplifier

INSTRUCTIONAL MATERIALS

Student Manuals:

Prentice-Hall, Troubleshooting: A Self-Instructional Programmed Manual

Tools and Equipment:

a. Vacuum tube amplifier
b. Test equipment
c. Schematic and manual
d. Screwdrivers, blade, assorted
e. Screwdrivers, Phillips head, assorted
f. Wrenches, adjustable
g. Iron, soldering
h. Solder, resin core
i. Pliers, needle nose
j. Pliers, diagonal
k. Flashlight

LAB HOURS	3
CLASS HOURS	3

EVALUATION (LFT-02)

Given a vacuum tube amplifier, the schematic and the necessary tools and test equipment, the student will test the amplifier for normal and abnormal operation. Malfunctions must be corrected so that the amplifier performs to the standards of the specification manual.

TASK

LFT-03 Testing and repairing a transistor amplifier

PERFORMANCE OBJECTIVE

Test and repair a transistor amplifier.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Normal operating conditions of the transistor amplifier
b. Troubleshooting a standard transistor amplifier
c. Basic repair procedures

Provide Demonstration On:

a. Testing the transistor amplifier for normal operation
b. Some abnormal operating conditions of a transistor amplifier
c. Standard method to troubleshoot the amplifier

Provide Practical Application On:

a. Practicing checking out the operation of some transistor amplifiers
b. Demonstrating how to troubleshoot the amplifier for different types of malfunctions

INSTRUCTIONAL MATERIALS

Textbooks:

a. Lenk, Handbook of Practical Solid State Troubleshooting
b. Lenk, Handbook of Modern Solid State Amplifiers

Student Manuals:

Prentice-Hall, Electronic Troubleshooting: A Self-Instructional Programmed Manual

Tools and Equipment:

a. Transistor amplifier
b. Test equipment
c. Schematic and manual
d. Screwdrivers, blade, assorted
e. Screwdrivers, Phillips head, assorted
f. Wrenches, adjustable
g. Iron, soldering
h. Solder, resin core

(Continued on back)

LAB HOURS	9
CLASS HOURS	3

EVALUATION (LFT-03)

Given a transistor amplifier, the schematic and the necessary tools and test equipment, the student will test the amplifier for normal and abnormal operation. Malfunctions must be corrected so that the amplifier performs to the standards of the specification manual.

INSTRUCTIONAL MATERIALS

Tools and Equipment:

i. Pliers, needle nose
j. Pliers, diagonal
k. Flashlight

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TASK

LFT-04 Identifying component parts and electrical characteristics of power supply circuits

PERFORMANCE OBJECTIVE

Identify the component parts and electrical characteristics of a power supply circuit.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Rectifier circuits
   1. Half-wave rectifiers
   2. Full-wave rectifiers
   3. Bridge rectifiers
b. Power supply filters
   1. The capacitor as a filter
   2. Percent ripple
   3. RC filters
   4. LC filters
c. Voltage multipliers
   1. Half-wave voltage double
   2. Full-wave voltage double
   3. Voltage tripler

(Continued on back)

Provide Demonstration On:

a. Unregulated power supplies
b. Operation and characteristics of the shunt regulator and the series regulator

Provide Practical Application On:

a. Constructing a power supply circuit using a kit
b. Identifying the component parts and electrical characteristics of the power supply circuit

INSTRUCTIONAL MATERIALS

Textbooks:

a. Heathkit, Electronic Circuits
b. Grob, Basic Electronics

Student Manuals:

a. Heathkit, Electronic Circuits, Student Workbook
b. Georgia, Electronics, Phase B

Tools and Equipment:

a. Heathkit Experimenter (ET-3100 or equivalent)
b. Oscilloscope with leads
c. Voltmeter with leads
d. Silicon diodes
e. 10 microfarad, 70 volt, electrolytic capacitor
f. 100 microfarad, 50 volt, electrolytic capacitor
g. 5600 ohm, ½-watt resistor

(Continued on back)

LAB HOURS	6
CLASS HOURS	3

EVALUATION (LFT-04)

a. Given a power supply circuit and the necessary supplies and equipment, the student will identify the component parts and electrical characteristics of the circuit. Component parts must be correctly identified. The electrical characteristics of the circuit must be identified.

b. Test and review questions can be found in:
   1. Heathkit, Electronic Circuits, Student Workbook.
   2. Georgia, Electronics, Phase B.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

d. Voltage regulation
   1. Load regulation
   2. The zener regulator
e. Series voltage regulator
   1. The emitter follower regulator
   2. The feedback regulator
   3. The feedback regulator with operational amplifier
   4. Short circuit protection
f. Power supply circuits
   1. Overload protection devices
   2. Protective circuits
   3. Shunt regulators
   4. 1 C regulators
5. 5. Oscilloscope power supply
   6. Color TV power supply
   7. ET-3100 power supply

INSTRUCTIONAL MATERIALS

Tools and Equipment:

h. 22 k ohm, ½-watt resistor
i. Silicon transistor (417-818)
j. Three silicon transistors (417-801)
k. 2.7 V zener diode
l. 6.2 V zener diode
m. 721C operational amplifier
n. Two silicon diodes (57-27)
o. 10 ohm, ½-watt resistor
p. 100 ohm, ½-watt resistor
q. 150 ohm, ½-watt resistor
r. 220 ohm, ½-watt resistor
s. 330 ohm, ½-watt resistor
t. 620 ohm, ½-watt resistor
u. Three 1000 ohm, ½-watt resistors
v. 1800 ohm, ½-watt resistor
w. 47 k ohm, ½-watt resistor
x. One k ohm potentiometer (built into ET-3100)
y. 100 k ohm potentiometer (built into ET-3100)

TASK

LFT-05 Testing and repairing power supplies

PERFORMANCE OBJECTIVE

Perform an operational check on a power supply and repair any malfunction that may exist.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Standard operation of the power supply
b. Voltage specifications
c. Types of malfunctions
d. Types of test equipment to be used to locate trouble
e. Correcting malfunctions

Provide Demonstration On:

a. How to check the different voltages in the power supply
b. How the power supply electrically operates
c. The steps used to locate malfunctions in the power supply

Provide Practical Application On:

a. Operating a good power supply and check voltages of the normal power supply
b. Explaining how to troubleshoot the circuit if abnormal voltages exist

INSTRUCTIONAL MATERIALS

Textbooks:

Grob, Basic Electronics

A/Vs:

Films from the USAF

Student Manuals:

Prentice-Hall, Electronic Troubleshooting: A Self-Instructional Programmed Manual

Tools and Equipment:

a. Power supplies, good and bad
b. Oscilloscope
c. VTVM
d. Schematic
e. Operation manual
f. Screwdrivers, blade assorted
g. Screwdrivers, Phillips head, assorted

(Continued on back)

LAB HOURS	3
CLASS HOURS	3

EVALUATION (LFT-05)

Given a power supply, schematic and the necessary tools and equipment, the student will check a power supply for correct operation and correct any malfunction. Malfunctions must be corrected so that the level of power conforms to the manufacturer's specifications.

INSTRUCTIONAL MATERIALS

Tools and Equipment:

h. Wrenches, adjustable
i. Iron, soldering
j. Solder, resin core
k. Pliers, needle nose
l. Pliers, diagonal
m. Flashlight

TASK

HFT-01 Testing and repairing oscillators

PERFORMANCE OBJECTIVE

Perform an operational check on an oscillator and repair any defective circuits.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Oscillator operation and theory
b. Types of oscillators
c. Methods of testing oscillators
d. Methods of calibration

Provide Demonstration On:

a. How the oscillator works
b. Some abnormal symptoms
c. Some common defects
d. Basic repair techniques

Provide Practical Application On:

a. Testing and calibrating oscillator circuits
b. Troubleshooting and repairing defective oscillator circuits

INSTRUCTIONAL MATERIALS

Textbooks:

a. Shrader, Electronic Communication
b. Horowitz and Hill, The Art of Electronics
c. Heathkit, Electronic Circuits

Student Manuals:

a. Heathkit, Electronic Circuits, Student Workbook
b. Georgia, Electronics, Phase C

Tools and Equipment:

a. Oscillator circuit
b. Oscilloscope
c. VOM
d. Schematic
e. Screwdrivers, blade, assorted
f. Screwdrivers, Phillips head, assorted
g. Wrenches, adjustable
h. Iron, soldering
i. Solder, resin core

(Continued on back)

LAB HOURS	9
CLASS HOURS	3

EVALUATION (HTF-01)

Given both good and defective oscillator circuits, schematics and the necessary tools and equipment, the student will identify the defective circuits and make the necessary repair(s). The repaired circuits must operate according to specifications.

INSTRUCTIONAL MATERIALS

Tools and Equipment:

j. Pliers, needle nose
k. Pliers, diagonal
l. Flashlight

TASK

HFT-02 Testing and repairing clampers

PERFORMANCE OBJECTIVE

Perform an operational check on a clamper circuit and repair any malfunction that may exist.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Clamper theory and operation
b. Troubleshooting the clamper with test equipment

Provide Demonstration On:

a. The clamper circuit
b. Some abnormal operating conditions of the clamper
c. How to troubleshoot and repair the clamper

Provide Practical Application On:

a. Testing the clamper circuit and identifying the defective circuits
b. Repairing any defect and retesting the clamper circuit

INSTRUCTIONAL MATERIALS

Textbooks:

McGraw-Hill, A Programmed Course in Basic Pulse Circuits

Tools and Equipment:

a. Clamper circuit
b. Voltmeter
c. Oscilloscope
d. Schematic
e. Screwdrivers, blade, assorted
f. Screwdrivers, Phillips head, assorted
g. Wrenches, adjustable
h. Iron, soldering
i. Solder, resin core

(Continued on back)

LAB HOURS	9
CLASS HOURS	3

EVALUATION (HFT-02)

Given a clamper circuit, schematic and the necessary tools and equipment, the student will perform an operational check on the circuit and repair any malfunction(s). The repaired circuit must meet the specified standards of operation.

INSTRUCTIONAL MATERIALS

Tools and Equipment:

j. Pliers, needle nose
k. Pliers, diagonal
l. Flashlight

TASK

HFT-03 Testing and repairing clipper circuits

PERFORMANCE OBJECTIVE

Perform an operational check on a clipper circuit and repair any malfunction that may exist.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Clipper circuit theory and operation
b. Troubleshooting the clipper test equipment
c. Basic repair techniques of the clipper

Provide Demonstration On:

a. Testing the clipper circuit for correct operation
b. Some abnormal operating conditions of a clipper circuit
c. How to troubleshoot and repair the clipper circuit

Provide Practical Application On:

a. Testing clipper circuits and identifying the defective circuits
b. Repairing any defects and retesting the clipper circuit

INSTRUCTIONAL MATERIALS

Textbooks:

McGraw-Hill, A Programmed Course in Basic Pulse Circuits

Tools and Equipment:

a. Clipper circuit
b. Oscilloscope
c. Voltmeter
d. Schematic
e. Screwdrivers, blade, assorted
f. Screwdrivers, Phillips head, assorted
g. Wrenches, adjustable
h. Iron, soldering
i. Solder, resin core

(Continued on back)

LAB HOURS	9
CLASS HOURS	3

EVALUATION (HFT-03)

Given a clipper circuit, schematic and the necessary tools and equipment, the student will perform an operational check on the circuit and repair any malfunction(s). The repaired circuit must meet the specified standards of operation.

INSTRUCTIONAL MATERIALS

Tools and Equipment:

j. Pliers, needle nose
k. Pliers, diagonal
l. Flashlight

532

TASK

HFT-04 Testing and repairing counters

PERFORMANCE OBJECTIVE

Perform an operational check on a counter circuit and repair any malfunction that may exist.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Counter theory and operation
b. Troubleshooting the counter with test equipment
c. Basic repair techniques of the counter

Provide Demonstration On:

a. How to test the counter circuit
b. Some abnormal operating conditions of the counter
c. How to troubleshoot and repair the counter

Provide Practical Application On:

a. Testing the counter circuits and identifying the defective circuits
b. Repairing any defects and retesting the counter circuits

INSTRUCTIONAL MATERIALS

Textbooks:

a. Triebel, *Integrated Digital Electronics*
b. Tokheim, *Digital Electronics*
c. Heathkit, *Digital Techniques*

Tools and Equipment:

a. Counter circuit
b. Voltmeter
c. Digital probe
d. Oscilloscope
e. Schematic
f. Screwdrivers, blade, assorted
g. Screwdrivers, Phillips head, assorted
h. Wrenches, adjustable

(Continued on back)

LAB HOURS	9
CLASS HOURS	3

EVALUATION (HFT-04)

Given a counter circuit, schematic and the necessary tools and equipment, the student will perform an operational check on the circuit and repair any malfunction(s). The repaired circuit must meet the specified standards of operation.

INSTRUCTIONAL MATERIALS

Tools and Equipment:

i. Iron, soldering
j. Solder, resin core
k. Pliers, needle nose
l. Pliers, diagonal
m. Flashlight

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TASK

HFT-05 Constructing oscillators and performing a condition test of the oscillators

PERFORMANCE OBJECTIVE

Construct an oscillator and perform a condition test of the oscillators.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Characteristics of a basic oscillator
b. Transformer oscillators
    1. Tuned-collector oscillators
    2. Tuned-base oscillators
c. LC oscillators
    1. The series-fed Hartley oscillator
    2. The shunt-fed Hartley oscillator
    3. Crystal Colpitts and Clapp oscillator

(Continued on back)

Provide Demonstration On:

a. The practical tank circuit
b. LC oscillators (Colpitts and Hartley)
c. Crystal oscillators (Colpitts and Pierce)
d. The Wien-bridge oscillator

Provide Practical Application On:

a. Constructing an oscillator using a kit
b. Performing condition tests using the master procedure

INSTRUCTIONAL MATERIALS

Textbooks:

Heathkit, Electronic Circuits

Student Manuals:

a. Heathkit, Electronic Circuits, Student Workbook
b. Georgia, Electronics, Phase C

Tools and Equipment:

a. Experimenter
b. Oscilloscope with leads
c. VOM (Heathkit IM-17 or equivalent)
d. 47 microhenry
e. NPN transistor
f. 3579.545 kilohertz crystal
g. 4.7 pF capacitor
h. 24 pF capacitor
i. 47 pF capacitor

(Continued on back)

LAB HOURS	9
CLASS HOURS	3

EVALUATION (HFT-05)

a. Given the necessary instructions, supplies and equipment, the student will construct an oscillator and perform a condition test of the oscillator. The oscillator must operate according to specifications.

b. Test and review questions can be found in:
   1. Heathkit, Electronic Circuits.
   2. Georgia, Electronics, Phase C.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

d. Controlled oscillators
   1. Equivalent crystal circuits
   2. The Hartley Crystal oscillator
   3. The Colpitts Crystal oscillator
   4. The Pierce oscillator
   5. The Butler oscillator
e. RC oscillators
   1. The phase-shift oscillator
   2. The Wein-bridge oscillator
f. Nonsinusoidal oscillators
   1. The blocking oscillator
   2. A sawtooth blocking oscillator
g. High frequency oscillators

INSTRUCTIONAL MATERIALS

Tools and Equipment:

j. Two .01 microfarad capacitors
k. Two .001 microfarad capacitors
l. 560 ohm, 1/2-watt resistor
m. 1500 ohm, 1/2-watt resistor
n. 8200 ohm, 1/2-watt resistor
o. Two 10 k ohm, 1/2-watt resistor
p. 47 k ohm, 1/2 watt resistor
q. Two 100 k ohm, 1/2-watt resistor
r. Two 1 M ohm, 1/2-watt resistor
s. 305 microhertz inductor
t. Two .1 microfarad capacitors
u. 22 k ohm, 1/2-watt resistor
v. 4.7 ohm, 1/2-watt resistor
w. Two 100 pF capacitors
x. 470 pF capacitor
y. 741 C operational amplifier
z. Incandescent lamp
aa. 220 ohm, 1/2-watt resistor
bb. One k ohm potentiometer (built into ET-3100)
cc. 30-watt soldering iron

TASK

HFT-06 Constructing and performing condition tests of pulse circuits

PERFORMANCE OBJECTIVE

Construct a pulse circuit and perform a condition test of the circuit.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Nonsinusoidal wave forms
    1. Frequency domain analysis
    2. Wave form spectrum
b. Wave shaping
    1. RC wave shaping by differentiator
    2. RC waveshaping by integrator
    3. Types of diode clipping circuits
    4. Transistor clippers
    5. Clampers

(Continued on back)

Provide Demonstration On:

a. Wave shaping
b. Operation and characteristics of various rectangular-wave generators
c. Ramp generators

Provide Practical Application On:

Constructing a pulse circuit and performing a condition test of the circuit

INSTRUCTIONAL MATERIALS

Textbooks:

Heathkit, Electronic Circuits

Student Manuals:

Heathkit, Electronic Circuits, Student Workbook

Tools and Equipment:

a. Heathkit, Experimenter (ET-3100 or equivalent)
b. Oscilloscope with leads
c. Multimeter with leads
d. Two NPN silicon transistors
e. Two silicon diodes
f. "555 Timer" 1C
g. 100 ohm, 1/2-watt resistor
h. Three 1000 ohm, 1/2 watt resistors
i. 1500 ohm, 1/2 watt resistor

(Continued on back)

LAB HOURS	9
CLASS HOURS	3

EVALUATION (HFT-06)

a. Given the necessary instructions, supplies and equipment, the student will construct a pulse circuit and perform a condition test of the circuit. The pulse circuit must operate according to specifications.

b. Test and review questions may be found in: Heathkit, Electronics Circuits, Student Workbook.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

c. Rectangular wave generators
    1. Astable multivibrator
    2. Monostable multivibrator
    3. Bistable multivibrator
    4. Schmitt trigger
    5. The 555 timer

d. Ramp generators
    1. Forming the ramp
    2. Operational amplifier
    3. Sawtooth generator

INSTRUCTIONAL MATERIALS

Tools and Equipment:

j. Two 3300 ohm, 1/2-watt resistors
k. Two 10 k ohm, 1/2-watt resistors
l. Two 0.1 microfarad capacitors
m. Two 0.01 microfarad capacitors
n. 0.001 microfarad capacitor
o. 0.039 microfarad capacitor
p. 0.02 microfarad capacitor
q. 100 k ohm potentiometer (built into ET-3100)
r. 4700 ohm, 1/2-watt resistor
s. 22 k ohm, 1/2-watt resistor
t. One M ohm, 1/2-watt resistor
u. Silicon transistor
v. Silicon diode
w. 2.7 V zener diode
x. 6.2 V zener diode
y. 741 C operational amplifier
z. PNP transistor
aa. .68 microfarad capacitor
bb. .0022 microfarad capacitor
cc. 100 k ohm potentiometer (built into ET-3100)
dd. One k ohm potentiometer (built into ET-3100)
ee. Oscilloscope with probes
ff. .001 microfarad ceramic capacitor
gg. .1 microfarad Mylar capacitor

TASK

HFT-07 Testing and repairing nonsinusoidal amplifiers

PERFORMANCE OBJECTIVE

Perform an operational check on a nonsinusoidal wave shaping amplifier and repair any defect in the amplifier.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Wave shaping circuit operation
b. Theory of wave shaper circuits
c. Discrete and IC wave shaper circuits
d. Method of troubleshooting

Provide Demonstration On:

a. How to test the wave shaping circuit
b. Normal malfunctions of wave shaper circuit
c. How to troubleshoot
d. How to repair

Provide Practical Application On:

a. Inspecting and testing good wave shaper circuits
b. Troubleshooting and repairing wave shaper circuit

INSTRUCTIONAL MATERIALS

Textbooks:

a. Heathkit, Active Filters
b. Heathkit, IC Timers
c. Heathkit, Electronic Circuits
d. Horowitz and Hill, The Art of Electronics

Student Manuals:

Heathkit, Electronic Circuits, Student Workbook

Tools and Equipment:

a. Wave shaper circuits
b. Oscilloscope
c. Voltmeter
d. Schematic manual
e. Manual
f. Screwdrivers, blade, assorted
g. Screwdrivers, Phillips head, assorted
h. Wrenches, adjustable
i. Iron, soldering

(Continued on back)

LAB HOURS	9
CLASS HOURS	3

EVALUATION (HFT-07)

Given a wave shaping amplifier, schematic and the necessary tools and equipment, the student will perform an operational check on the amplifier and repair any malfunctions. The repaired amplifier must meet the specified standards of operation.

INSTRUCTIONAL MATERIALS

Tools and Equipment:

j. Solder, resin core
k. Pliers, needle nose
l. Pliers, diagonal
m. Flashlight

TASK

HFT-08 Troubleshooting sweep-generator circuits

PERFORMANCE OBJECTIVE

Perform an operational check on a sweep-generator circuit and repair any malfunction that may exist.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Sweep-generator theory and operation
b. Troubleshooting with test equipment
c. Basic repair techniques

Provide Demonstration On:

a. Testing the sweep-generator circuits
b. Abnormal operating conditions of the generator
c. Troubleshooting and repairing the generator

Provide Practical Application On:

a. Testing sweep-generator circuits and identifying the defective circuits
b. Repairing any defects and retesting the generator circuits

INSTRUCTIONAL MATERIALS

Textbooks:

a. McGraw-Hill, A Programmed Course in Basic Pulse Circuits
b. Heathkit, Electronic Circuits

Tools and Equipment:

a. Sweep-generator
b. Oscilloscope
c. Schematic and manual
d. Hand tools
e. Voltmeter
f. Screwdrivers, blade, assorted
g. Screwdrivers, Phillips head, assorted
h. Wrenches, adjustable
i. Iron, soldering

(Continued on back)

LAB HOURS	9
CLASS HOURS	3

EVALUATION (HFT-08)

Given a sweep-generator, manual schematic and the necessary tools and equipment, the student will perform an operational check on the circuits. Any malfunctions must be identified and corrected to operational specifications.

INSTRUCTIONAL MATERIALS

Tools and Equipment:

j. Solder, resin core
k. Pliers, needle nose
l. Pliers, diagonal
m. Flashlight

TASK

HFT-09 Troubleshooting electronic circuits

PERFORMANCE OBJECTIVE

Trace an electronic circuit and locate the component that is defective.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Troubleshooting procedure
b. How to trace a circuit using a schematic
c. The theory of circuit under study
d. Using data to locate defective parts

Provide Demonstration On:

a. Demonstrating the troubleshooting procedure
b. Tracing the circuit under study
c. Interpreting data to identify defective part

Provide Practical Application On:

a. Tracing and drawing a schematic of the circuit under study
b. Measuring and recording data and interpreting the data to locate the defective component

INSTRUCTIONAL MATERIALS

Textbooks:

Prentice-Hall, Electronic Troubleshooting: A Self-Instructional Programmed Manual

Tools and Equipment:

a. Circuits to be traced for trouble
b. Schematic with data
c. Voltmeter
d. Oscilloscope

LAB HOURS	9
CLASS HOURS	3

EVALUATION (HFT-09)

Given electronic circuits, schematics with data and the necessary tools and equipment, the student will trace the circuit and identify the defective component(s). All defective components must be identified.

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TASK

HFT-10 Performing a condition test of zener diodes used in regulator circuits

PERFORMANCE OBJECTIVE

Perform a condition test of zener diodes used in regulator circuits.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Zener diode characteristics
    1. Voltage-current characteristics
    2. Zener voltage
b. Power dissipation in zener diodes
    1. Power-temperature curves
    2. Derating factor
c. Current limitations in zener diodes
d. Effects of temperature on zener voltage
e. Temperature compensated zener diodes
f. Zener diode impedance
g. Zener diode packages

Provide Practical Application On:

a. The zener diode and its use as a voltage regulator
b. Constructing a zener diode regulator circuit

INSTRUCTIONAL MATERIALS

Textbooks:

a. Heathkit, Semi-Conductor Devices
b. Georgia, Electronics, Phase B
c. Zbar, Basic Electricity

Student Manuals:

a. Georgia, Electronics, Phase B, Unit 3-B
b. Heathkit, Semi-Conductor Devices
c. Zbar, Basic Electricity

Tools and Equipment:

a. Heathkit Electronic Design Experimenter (ET-3100 or equivalent)
b. Voltmeter with test leads
c. 47 ohm, ½-watt resistor
d. 100 ohm, ½-watt resistor
e. 220 ohm, ½-watt resistor
f. 470 ohm, ½-watt resistor
g. 1000 ohm, ½-watt resistor
h. 1N751 +10%, 500 milliwatts
i. 1000 ohm potentiometer

LAB HOURS 9

CLASS HOURS 3

EVALUATION (HFT-10)

a. Given the tools and equipment listed for this unit, the student will construct a zener diode regulator circuit incorporating a 1000 microfarad potentiometer and will measure and record diode voltage, diode current and output voltage at various resistance levels and range of output loads.

b. Test and review questions can be found in:
   1. Georgia, Electronics, Phase B, Unit 3-B.
   2. Heathkit, Semi-Conductor Devices.

TASK

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CTI-01 Performing condition test and calibration of volt-ohm-milliammeter (VOM)

PERFORMANCE OBJECTIVE

Perform a functional condition test and calibrate to determine if operational range of a VOM is within specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Types of VOMs
b. Simplified circuit
   1. Voltmeter
   2. Ohmmeter
   3. Milliammeter
c. Specific differences of various types and models of VOMs
d. The use of standards for comparison during calibration process
e. Traceability of standards from working (bench) to National Bureau of Standards (NBS)

(Continued on back)

Provide Demonstration On:

a. Selecting a standard
b. Calibration procedure
c. Decision to accept or reject test instrument
d. Initiating corrective action on rejects

Provide Practical Application On:

a. Selecting a standard
b. Procedures for calibration
c. Decisions to accept or reject test instrument
d. Writing a repair order for items not meeting specifications

INSTRUCTIONAL MATERIALS

Textbooks:

a. Test instrument service manual
b. Standards service manuals
c. Noll, Basic Electronics Math with a Scientific Calculator

Tools and Equipment:

a. Screwdrivers
b. Wrenches
c. Pliers
d. Flashlight
e. Calibration procedure
f. DC standard
g. Calibrated leads
h. Calculator

LAB HOURS	9
CLASS HOURS	3

EVALUATION (CTI-01)

a. Given a calibration standard, VOM, tools, references and supplies, the student will perform a condition test and calibration of the VOM. A written analysis of data collected will indicate acceptance or rejection of the unit. Rejections will require initiating a repair order.

b. U.S. Army, Calibration Specialist: Skill Levels 1 and 2.

c. U.S. Army, Calibration Specialist: Skill Level 3.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

f. Types of standards
g. Performing condition test
h. Calibration procedure

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TASK

CTI-02 Performing condition test and calibration of electrical voltmeters (EVM)

PERFORMANCE OBJECTIVE

Perform a functional condition test and calibrate to determine if operational range of an EVM is within specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Types and models of EVM
b. Simplified circuit
    1. Loading (input)
    2. Range selection
    3. Internal standard
    4. Comparitor network
    5. Output circuit
    6. Indicator
c. Specific differences of various types and models
d. Selection of a standard
e. Performing a condition test
f. Performing a calibration

Provide Demonstration On:

a. Selecting a standard
b. Calibration procedure
c. Decision to accept or reject the test instrument
d. Initiating corrective action on rejected items

Provide Practical Application On:

a. Selecting a standard
b. The calibration process
c. Decisions to accept or reject the test instrument
d. Writing a repair order for items not meeting specifications

INSTRUCTIONAL MATERIALS

Textbooks:

a. Test instrument service manual
b. Standards service manuals
c. Noll, Basic Electronics Math with a Scientific Calculator

Tools and Equipment:

a. Screwdrivers
b. Wrenches
c. Pliers
d. Flashlight
e. Calibration procedure
f. AC standard
g. Calibration leads
h. Calculator

LAB HOURS	9
CLASS HOURS	3

EVALUATION (CTI-02)

a. Given a calibration standard, EVM, tools, references and supplies, the student will perform a condition test and calibration of the EVM. A written analysis of data collected will indicate acceptance or rejection of the item. Rejections will require initiating a repair order.

b. U.S. Army, Calibration Specialist: Skill Levels 1 and 2.

c. U.S. Army, Calibration Specialist: Skill Level 3.

TASK

CTI-03 Performing condition test and calibration of tube testers

PERFORMANCE OBJECTIVE

Perform a functional condition test and calibrate to determine if operational range of a tube tester is within specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Types and models of tube testers
b. Simplified circuit
   1. Filament range
   2. Internal standard
   3. Tube element range selection
   4. Output circuit
   5. Short indicator
   6. Condition indicator
c. Specific differences of various types models
d. Selection of a standard
e. Performing a condition test (equipment service manual)
f. Performing a calibration

Provide Demonstration On:

a. Selecting a standard
b. Calibration procedure
c. Decision to accept or reject the test instrument
d. Initiating corrective action on rejected item

Provide Practical Application On:

a. Selecting a standard
b. The calibration process
c. Decisions to accept or reject the test instrument
d. Writing a repair order for an item not meeting specifications

INSTRUCTIONAL MATERIALS

Textbooks:

a. Test instrument service manual
b. Standards service manuals
c. Noll, Basic Electronics Math with a Scientific Calculator

Tools and Equipment:

a. Screwdrivers
b. Wrenches
c. Pliers
d. Flashlight
e. Calibration procedure
f. DC standard
g. AC standard
h. Electronic voltmeter
i. Calculator

LAB HOURS	9
CLASS HOURS	3

EVALUATION (CTI-03)

a. Given a calibration standard, tube tester, tools, references and supplies, the student will perform a condition test and calibration of the tube tester. A written analysis of data collected will indicate acceptance or rejection of the time. Rejections will require initiating a repair order.

b. U.S. Army, Calibration Specialist: Skill Levels 1 and 2.

c. U.S. Army, Calibration Specialist: Skill Level 3.

TASK

CIT-04 Performing condition test and calibration of a transistor tester

PERFORMANCE OBJECTIVE

Perform a functional condition test and calibrate to determine if operational range of transistor tester is within specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Types and models of transistor testers
b. Simplified circuit
    1. Power supply
    2. Internal standard
    3. Range selection for each element of transistor
    4. Output circuit
    5. Indicator circuit
c. Precaution to observe for
    1. In-circuit test
    2. Out-of-circuit test

(Continued on back)

Provide Demonstration On:

a. Selecting a standard
b. Calibration procedure
c. Decision to accept or reject the test instrument
d. Initiating corrective action on rejected item

Provide Practical Application On:

a. Selecting a standard
b. The calibration process
c. Decisions to accept or reject the test instrument
d. Writing a repair order for an item not meeting specifications

INSTRUCTIONAL MATERIALS

Textbooks:

a. Test instrument service manual
b. Standards service manuals
c. Noll, Basic Electronics Math with a Scientific Calculator

Tools and Equipment:

a. Screwdrivers
b. Wrenches
c. Pliers
d. Flashlight
e. Calibration procedure
f. DC standard
g. AC standard
h. Electronic voltmeter
i. Oscilloscope
j. Signal generator
k. Transistors
l. Calculator

LAB HOURS 9
CLASS HOURS 3

EVALUATION (CTI-04)

a. Given a calibration standard, transistor tester, tools, references and supplies, the student will perform a condition test and calibration of the transistor tester. A written analysis of data collected will indicate acceptance or rejection of the item. Rejections will require initiating a repair order.

b. U.S. Army, Calibration Specialist: Skill Levels 1 and 2.

c. U.S. Army, Calibration Specialist: Skill Level 3.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

d. Specific differences of various types and models
e. Selection of a standard
f. Performing the condition test
g. Performing the calibration

TASK

CTI-05 Performing condition test and calibration of resistor substitution box

PERFORMANCE OBJECTIVE

Perform a functional condition test and calibrate to determine if operational range of the resistor substitution box is within specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Types and models of resistor substitution boxes
b. Simplified circuit
    1. Total range
    2. Step switches
c. Specific difference of various types and models of resistor substitution boxes
    1. Range
    2. Steps
    3. Accuracy
    4. Power handling capability
d. Selection of a standard

(Continued on back)

Provide Demonstration On:

a. Selecting a standard
b. Calibration procedure
c. Decision to accept or reject the test instrument
d. Initiating corrective action on rejected item

Provide Practical Application On:

a. Selecting a standard
b. The calibration process
c. Decisions to accept or reject the test instrument
d. Writing a repair order for an item not meeting specifications

INSTRUCTIONAL MATERIALS

Textbooks:

a. Test instrument service manual
b. Standards service manuals
c. Noll, Basic Electronics Math with a Scientific Calculator

Tools and Equipment:

a. Screwdrivers
b. Wrenches
c. Pliers
d. Flashlight
e. Calibration procedure
f. Resistance bridge
g. Calculator

LAB HOURS	9
CLASS HOURS	3

EVALUATION (CTI-05)

a. Given a calibration standard, resistance substitution box, tools, references and supplies, the student will perform a condition test and calibration of the resistance substitution box. A written analysis of data collected will indicate acceptance or rejection of the item. Rejections will require initiating a repair order.

b. U.S. Army, Calibration Specialist: Skill Levels 1 and 2.

c. U.S. Army, Calibration Specialist: Skill Level 3.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

e. Performing a condition test (equipment service manual)
f. Performing a calibration

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TASK

CTI-06 Performing condition test and calibration of oscilloscopes

PERFORMANCE OBJECTIVE

Perform a functional condition test and calibrate to determine if operational range of an oscilloscope is within specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Types and models of oscilloscopes
b. Simplified circuit
    1. Voltage range (amplitude)
    2. Timing range (frequency)
    3. Deflection circuit
c. Special differences of various types and models of oscilloscopes
d. Selection of standards
e. Performing a condition test
f. Performing a calibration

Provide Demonstration On:

a. Selecting a standard
b. Calibration procedure
c. Decision to accept or reject the test instrument
d. Initiating corrective action on rejected items

Provide Practical Application On:

a. Selecting a standard
b. The calibration process
c. Decisions to accept or reject the test instrument
d. Writing a repair order for an item not meeting specifications

INSTRUCTIONAL MATERIALS

Textbooks:

a. Test instrument service manual
b. Standards service manuals
c. Noll, Basic Electronics Math with a Scientific Calculator

Tools and Equipment:

a. Screwdrivers
b. Wrenches
c. Pliers
d. Flashlight
e. Alignment tools (non-conductive)
f. Calibration procedure
g. AF and RF signal generators

(Continued on back)

LAB HOURS	9
CLASS HOURS	3

EVALUATION (CTI-06)

a. Given a calibration standard, oscilloscope, tools, references and supplies, the student will perform a condition test and calibration of the oscilloscope. A written analysis of data collected will indicate acceptance or rejection of the item. Rejections will require initiating a repair order.

b. U.S. Army, Calibration Specialist: Skill Levels 1 and 2.

c. U.S. Army, Calibration Specialist: Skill Level 3.

INSTRUCTIONAL MATERIALS

Tools and Equipment:

h. Constant amplitude generator
i. Timing calibrator
j. Electronic voltmeter
k. Frequency counter
l. Calculator

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TASK

CTI-07 Performing condition test and calibration of sine wave generators

PERFORMANCE OBJECTIVE

Perform a functional condition test and calibrate to determine if operational range of a sine wave generator is within specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Types and models of sine wave generators
b. Simplified circuit
    1. Basic oscillator
    2. Frequency determining components and method of variation
    3. Constant level output
    4. Amplitude control
c. Specific differences of various types and models of sine wave generators
d. Selection of standards
e. Performing a condition test
f. Performing a calibration

Provide Demonstration On:

a. Selecting a standard
b. Calibration procedure
c. Decision to accept or reject the test instrument
d. Initiating corrective action on rejected items

Provide Practical Application On:

a. Selecting a standard
b. The calibration process
c. Decisions to accept or reject the test instrument
d. Writing a repair order for an item not within specifications

INSTRUCTIONAL MATERIALS

Textbooks:

a. Test instrument service manual
b. Standards service manuals
c. Noll, *Basic Electronics Math with a Scientific Calculator*

Tools and Equipment:

a. Screwdrivers
b. Wrenches
c. Pliers
d. Flashlight
e. Alignment tools (non-conductive)
f. Calibration procedures
g. Electronic voltmeter
h. Frequency counter
i. Calculator

LAB HOURS 9

CLASS HOURS 3

EVALUATION (CTI-07)

a. Given a calibration standard, sine wave generator, tools, references and supplies, the student will perform a condition test and calibration of the sine wave generator. A written analysis of data collected will indicate acceptance or rejection of the item. Rejections will require initiating a repair order.

b. U.S. Army, Calibration Specialist: Skill Levels 1 and 2.

c. U.S. Army, Calibration Specialist: Skill Level 3.

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TASK

CTI-08 Performing condition test and calibration of square wave and pulse generators

PERFORMANCE OBJECTIVE

Perform a functional condition test and calibrate to determine if operational range of square wave and pulse generators are within specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Types and models
    1. Square wave
    2. Pulse
    3. Combinations (function generator)
b. Simplified cirucit
    1. Basic oscillator
    2. Shaping network
    3. Triggering network
    4. Amplitude control
c. Specific differences of various types and models of pulse and square wave generators
d. Selection of standards
e. Performing the condition test
f. Performing the calibration

Provide Demonstration On:

a. Selecting a standard
b. Calibration procedures
c. Decision to accept or reject the test instrument
d. Initiating corrective action on rejected items

Provide Practical Application On:

a. Selecting a standard
b. The calibration process
c. Decisions to accept or reject the test instrument
d. Writing a repair order on items not meeting specifications

INSTRUCTIONAL MATERIALS

Textbooks:

a. Test instrument service manual
b. Standards service manuals
c. Noll, Basic Electronics Math with a Scientific Calculator

Tools and Equipment:

a. Screwdrivers
b. Wrenches
c. Pliers
d. Flashlight
e. Alignment tools (non-conductive)
f. Calibration procedure
g. Electronic voltmeter
h. Frequency counter
i. Oscilloscope
j. Calculator

LAB HOURS	9
CLASS HOURS	3

EVALUATION (CTI-08)

a. Given a calibration standard, square wave and pulse generators, tools, references and supplies, the student will perform a condition test and calibration of the square wave and pulse generators. A written analysis of the data collected will indicate acceptance or rejection of the items. Rejections will require initiating a repair order.

b. U.S. Army, Calibration Specialist: Levels 1 and 2.

c. U.S. Army, Calibration Specialist: Level 3.

TASK

CTI-09 Performing condition test and calibration of frequency meters

PERFORMANCE OBJECTIVE

Perform a functional condition test and calibrate to determine if operational range of a frequency meter is within specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Types and models of frequency meters
b. Simplified circuit
  1. Input amplitude control
  2. Internal standard
  3. Comparitor network
  4. Output
  5. Indicator
c. Specific differences of various types and models of frequency meters
d. Selection of standards
e. Performing a condition test
f. Performing a calibration

Provide Demonstration On:

a. Selecting a standard
b. Calibration procedure
c. Decision to accept or reject the test instrument
d. Initiating corrective action on rejected items

Provide Practical Application On:

a. Selecting a standard
b. The calibration process
c. Decisions to accept or reject the test instrument
d. Writing a repair order for an item not within specifications

INSTRUCTIONAL MATERIALS

Textbooks:

a. Test instrument service manual
b. Standards service manuals
c. Noll, Basic Electronics Math with a Scientific Calculator

Tools and Equipment:

a. Screwdrivers
b. Wrenches
c. Pliers
d. Flashlight
e. Alignment tools (non-conductive)
f. Calibration procedure
g. Electronic counter
h. Signal generator
i. Pulse generator
j. Electronic voltmeter
k. Ratio transformer
l. Calculator

LAB HOURS	9
CLASS HOURS	3

EVALUATION (CTI-09)

a. Given a calibration standard, frequency meter, tools, references and supplies, the student will perform a condition test and calibration of the frequency meter. A written analysis of data collected will indicate acceptance or rejection of the item. Rejections will require initiating a repair order.

b. U.S. Army, Calibration Specialist: Skill Levels 1 and 2.

c. U.S. Army, Calibration Specialist: Skill Level 3.

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TASK

CTI-10 Calibrating power supply voltage

PERFORMANCE OBJECTIVE

Use the calibration procedure for a power supply as a method of troubleshooting a voltage malfunction within the power supply.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Normal calibration procedures
b. Troubleshooting steps
c. Locating the area of trouble
d. Troubleshooting to the component level

Provide Demonstration On:

a. Normal calibration
b. Recognizing an abnormal power supply
c. Using visual, test, area isolation and component level techniques to troubleshoot

Provide Practical Application On:

a. Calibrating some good power supplies
b. Calibrating power supplies with defective outputs
c. Writing a conclusion about what he/she believes is the problem

INSTRUCTIONAL MATERIALS

Textbooks:

Lemons, Learn Electronics Through Troubleshooting

Student Manuals:

Prentice-Hall, Electronic Troubleshooting: A Self-Instructional Programmed Manual

Tools and Equipment:

a. Power supplies, good and bad
b. Oscilloscope
c. VTVM
d. Screwdrivers, blade, assorted
e. Screwdrivers, Phillips head, assorted
f. Wrenches, adjustable
g. Iron, soldering

(Continued on back)

LAB HOURS	9
CLASS HOURS	3

EVALUATION (CTI-10)

Given a power supply and the necessary tools and equipment, the student will calibrate the power supply and troubleshoot the power supply by using the calibration procedure. The power supply must be calibrated or, if not, the problem must be identified in writing.

INSTRUCTIONAL MATERIALS

Tools and Equipment:

h. Solder, resin core
i. Pliers, needle nose
j. Pliers, diagonal
k. Flashlight

TASK

SIS-01 Identifying automatic control system functions

PERFORMANCE OBJECTIVE

Identify functions, process variable, measurement, control, set point, error and closed loop circuits of a control system.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Process variables
b. Automatic process control
c. Set point
d. Process control applications
e. Measuring variables
f. Controlling variables
g. Closed loop control circuits

Provide Demonstration On:

a. Functions of a control system and components which are required
b. Feedback path in closed loop circuit

Provide Practical Application On:

a. Sketching a complete control system
b. Naming component parts
c. Identifying operating range
d. Identifying measuring units involved

INSTRUCTIONAL MATERIALS

Textbooks:

a. Kirk, Instrumentation
b. Fribance, Industrial Instrumentation Fundamentals
c. ISA, Standards and Practices For Instrumentation
d. Stewart and Storer, Fluid Power

A/Vs:

ISA, "Automatic Process Control," movie film

Student Manuals:

TPC, Instrumentation and Process Control, Introduction to Process Control, Lesson One

Tools and Equipment:

Listing media

LAB HOURS	2
CLASS HOURS	1

EVALUATION (SIS-01)

Given the necessary references and materials, the student will identify the functions, process variables, measurement, control, set point, error and closed loop circuits of a control system to a minimum accuracy level of 80% or greater.

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TASK

SIS-02 Identifying the elements of process control

PERFORMANCE OBJECTIVE

Identify terms describing process control systems, components and measuring units.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Process loops and operation
b. Direct piping
c. Standardized central control
d. Measuring
    1. Process variables
    2. Pressure
    3. Level
    4. Flow rate
e. Control system nomenclature
f. Control methods
    1. Open loop
    2. Closed loop
g. Controller actions

Provide Demonstration On:

a. Historical development of system components and the names applied to these items
b. Historical development of measuring units for rating components

Provide Practical Application On:

a. Matching terms to diagrams, drawings and descriptions of control system elements
b. Matching elements to measuring units used to define operating range

INSTRUCTIONAL MATERIALS

Textbooks:

a. Kirk, Instrumentation
b. Fribance, Industrial Instrumentation Fundamentals
c. ISA, Standards and Practices For Instrumentation
d. Stewart and Storer, Fluid Power

A/Vs:

Foxboro, "The Values of Process Control," movie film

Student Manuals:

TPC, Instrumentation and Process Control, Introduction to Process Control, Lesson Two

Tools and Equipment:

Listing media

LAB HOURS	0
CLASS HOURS	1

EVALUATION (SIS-02)

Given the necessary references and materials, the student will identify the terms describing components and measuring units of a control system to an accuracy level of 80%.

TASK

SIS-03 Identifying system transmitters and receivers process loops

PERFORMANCE OBJECTIVE

Identify methods employed in transmitting information through process control systems.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Analog signals
b. Transducers
   1. Linear
   2. Nonlinear
c. Signal value range
d. Calculating
   1. Signal level
   2. Error level
   3. Controller output
e. Signal transmission:
   1. Pneumatic
   2. Electrical
   3. Combination system

Provide Demonstration On:

a. Development of analog signal
b. Transducer outputs
c. Calculating signal level
d. Various transmission systems used in process control circuits

Provide Practical Application On:

a. Identifying transducers
   1. Type
   2. Output range
   3. Calculating specific operating levels
b. Identifying various methods for transmitting information

INSTRUCTIONAL MATERIALS

Textbooks:

a. Kirk, Instrumentation
b. Fribance, Industrial Instrumentation Fundamentals
c. ISA, Standards and Practices For Instrumentation
d. Stewart and Storer, Fluid Power

A/Vs:

IFB, "Introduction to Control," movie film

Student Manuals:

TPC, Instrumentation and Process Control, Introduction to Process Control, Lesson Three

Tools and Equipment:

Listing media

LAB HOURS	0
CLASS HOURS	2

EVALUATION (SIS-03)

a. Given examples of various transducers, the student will list the type, output range, calculated signal value for specific conditions and transmission method for each to an accuracy level of 80%.

b. Neuschaefer, Industrial Process Control Program Manual of Experiment: Experiment C1, Pneumatic Pressure Transmitter.

TASK

SIS-04 Identifying diagram symbols and networks

PERFORMANCE OBJECTIVE

Identify from diagrams, system components and networks.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Instruments used
b. Components symbols
c. Network composition and associated symbols and variations
d. Using diagrams to analyze signal path through process control system

Provide Demonstration On:

a. Symbol and term linking
b. Network composition
c. Variations in diagramming control systems
d. Analyzing signal path

Provide Practical Application On:

a. Drawing symbols using templates
b. Drawing symbols free hand method
c. Diagramming networks using drawing media
d. Diagramming networks free hand method
e. Annotating signal path

INSTRUCTIONAL MATERIALS

Textbooks:

a. ISA, Standards and Practices for Instrumentation
b. Stewart and Storer, Fluid Power

Student Manuals:

TPC, Instrumentation and Process Control, Introduction to Process Control, Lesson Four

Tools and Equipment:

a. Paper
b. Pencil
c. Symbol templates
d. Straight edge
e. Angle guides
f. Drawing board

LAB HOURS	2
CLASS HOURS	1

EVALUATION (SIS-04)

Given necessary supplies and references, the student will diagram process control system components into networks and annotate signal paths to an accuracy level of 80%.

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TASK

SIS-05 Identifying parameters of an operational process control system

PERFORMANCE OBJECTIVE

Identify operating parameters of process control systems.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Process control operations
b. System signal levels
c. Variations in operational conditions
d. Controller efficiency
e. Control loops
    1. Pressure
    2. Single-variable
    3. Cascade
    4. Ratio
    5. Tuning

Provide Demonstration On:

a. Determining parameters for each mode of operation
b. Identifying system variations
c. Tuning a control loop

Provide Practical Application On:

a. Determining operational parameters of various systems
    1. Pressure
    2. Single
    3. Cascade
    4. Ratio
    5. Combination
b. Tuning systems for optimum operational parameters

INSTRUCTIONAL MATERIALS

Textbooks:

a. ISA, Standards and Practices for Instrumentation
b. Johnson, Process Control Instrumentation Technology
c. Stewart and Storer, Fluid Power

A/Vs:

Foxboro, "Fundamentals of Automatic Control," movie film

Student Manuals:

TPC, Instrumentation and Process Control, Introduction to Process Control, Lesson Five

Tools and Equipment:

a. Systems mock-ups
b. Systems trainers
c. Checklist with standards
d. Kit of tuning tools

LAB HOURS 3
CLASS HOURS 4

EVALUATION (SIS-05)

Given necessary tools and equipment, the student will tune a system for optimum operation and list the associated parameters to an accuracy level of 80%.

TASK

SIS-06 Identifying measurement purpose and requirements

PERFORMANCE OBJECTIVE

Identify the purpose and requirements measurement serves in process control systems.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Measurement
    1. Purpose
    2. Requirement
    3. Variations in use
    4. Remote display
    5. Local display
    6. Response time
b. Measurement error
    1. System deterioration
    2. Due to observation
    3. Noise
c. Measurement calibration

Provide Demonstration On:

a. Purpose of measurement
b. Causes of measurement error
c. Calibration principles

Provide Practical Application On:

a. Distinguishing between control and monitoring measurements
b. Describing measurement procedures
c. Distinguishing between
    1. Linear verses nonlinear
    2. Local verses remote measurements
d. Defining calibration needs

INSTRUCTIONAL MATERIALS

Textbooks:

Herceg, *Handbook of Measurement and Control*

Student Manuals:

TPC, Instrumentation and Process Control, *Foundations of Measurement Instrumentation, Lesson One*

Tools and Equipment:

Listing media

LAB HOURS 1

CLASS HOURS 1

EVALUATION (SIS-06)

Given necessary references, the student will list measurement requirements for process control system to an accuracy level of 80%.

TASK

SIS-07 Identifying the elements of measurement systems

PERFORMANCE OBJECTIVE

Identify measurement requirements of transduction, signal conditioning and transmission.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Component interaction
b. Creating a measurement signal
    1. Pneumatic
    2. Electrical
c. Signal transmission
d. Indicators

Provide Demonstration On:

a. Functions of measuremental systems
    1. Transduction
    2. Signal conditioning
    3. Transmission
b. Various measurement indicators

Provide Practical Application On:

a. Describing transducer functions
b. Distinguishing between analog and digital signals
c. Describing process control systems indicators

INSTRUCTIONAL MATERIALS

Textbooks:

a. Herceg, Handbook of Measurement and Control
b. Patrick and Patrick, Instrumentation Training Course: Volume 1, Pneumatic Instruments
c. Patrick, Instrumentation Training Course: Volume 2, Electronic Instruments

Student Manuals:

TPC, Instrumentation and Process Control, Foundations of Measurement Instrumentation, Lesson Two

Tools and Equipment:

Listing media

LAB HOURS	1
CLASS HOURS	1

EVALUATION (SIS-07)

Given necessary references, the student will describe measurement transducers, signal conditioning and transmission to an accuracy level of 80%.

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TASK

SIS-08 Identifying measurement transducers

PERFORMANCE OBJECTIVE

Identify the type and characteristic output of transducers.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Matching transducer to process control system requirement
b. Components of transducers
    1. Mechanical
    2. Electrical
c. Designed range of response
d. False or error signals

Provide Demonstration On:

a. Various types of transducers
b. Operational characteristic of transducers
c. Causes of error signals

Provide Practical Application On:

a. Identifying transducers and their characteristics
b. Identifying incorrect responses

INSTRUCTIONAL MATERIALS

Textbooks:

a. Considine, Process Instruments and Control Handbook
b. Fribance, Industrial Instrumentation Fundamentals
c. Johnson, Process Control Instrumentation Technology
d. Kirk, Instrumentation
e. Liptak, Instrument Engineer's Handbook
f. ISA, Basic Instrumentation Lecture Notes and Study Guide: Part 1, Measurement Fundamentals

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Student Manuals:

TPC, Instrumentation and Process Control, Foundations of Measurement Instrumentation, Lesson Three

Tools and Equipment:

Listing media

LAB HOURS 1

CLASS HOURS 1

EVALUATION (SIS-08)

Given necessary references and various different measurement transducers, the student will identify the type and characteristics of each to an accuracy level of 80%.

INSTRUCTIONAL MATERIALS

Textbooks:

g. ISA, Standards and Practices for Instrumentation
h. Stewart and Storer, Fluid Power

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TASK

SIS-09 Identifying instrument calibration standards units

PERFORMANCE OBJECTIVE

Identify the measuring units of instrument standards.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Need for stating specifications
b. Field of accuracy
c. Definition of precision
d. Resolution
e. Sensitivity
f. Transfer efficiency
g. Time response
h. Time constant
i. Measurement units
    1. SI
    2. English
j. Calibration standards
k. Calibration laboratory

Provide Demonstration On:

a. Units of measurement systems
b. Units of SI systems
c. Elements of instrument calibration
d. Calibration standard versus tested instrument accuracy ratio

Provide Practical Application On:

a. Identifying minimum specification of instruments

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

a. Considine, Process Instruments and Control Handbook
b. Fribance, Industrial Instrumentation Fundamentals
c. Johnson, Process Control Instrumentation Technology
d. Kirk, Instrumentation
e. Liptak, Instrument Engineer's Handbook
f. ISA, Basic Instrumentation Lecture Notes and Study Guide: Part 1, Measurement Fundamentals

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Student Manuals:

TPC, Instrumentation and Process Control, Foundations of Measurement Instrumentation, Lesson Four

Tools and Equipment:

Listing media

LAB HOURS	2
CLASS HOURS	1

EVALUATION (SIS-09)

Given necessary references and selected instruments, the student will list the measuring units specifications are written to and the standards used in verifying each instrument. Responses must be to an accuracy level of 80%.

INSTRUCTIONAL ACTIVITIES

Provide Practical Application On:

b. Identifying various measuring standards and the units associated with each
c. Identifying standards used to verify

INSTRUCTIONAL MATERIALS

Textbooks:

g. ISA, Standards and Practices for Instrumentation

TASK

SIS-10 Analyzing systems using troubleshooting flow sheet

PERFORMANCE OBJECTIVE

Compare system operation with condition statements and decision questions of troubleshooting flow sheet.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Process control instrument shop facilities
b. Control of hazardous substances
c. Scheduling calibration request
d. Definition of primary standards
e. Working standards
f. Following "decision tree" troubleshooting flow sheet

Provide Demonstration On:

a. Layout of repair and calibration facility
b. Hazardous substance control
c. Primary and working standards
d. Use of data flow sheets

Provide Practical Application On:

a. Developing hazardous substance control checklist
b. Developing procedures for control of primary and working standards

(Continued on back)

INSTRUCTIONAL MATERIALS

A/Vs:

TPC, "Supervisor's Unit Guide, Foundations of Measurement Instrumentation," transparencies

Student Manuals:

TPC, Instrumentation and Process Control, Foundations of Measurement Instrumentation, Lesson Five

Tools and Equipment:

a. Checklist development media
b. System mock-up or trainer
c. Inventory of primary standards
d. Inventory of working standards

LAB HOURS	2
CLASS HOURS	1

EVALUATION (SIS-10)

Given necessary references, tools and equipment, the student will compare system operation with data on flow sheet and annotate conditions. Responses must be to an accuracy level of 80% or greater.

INSTRUCTIONAL ACTIVITIES

Provide Practical Application On:

c. Describing equipment for calibration
d. Locating data flow sheets
e. Comparing system operation to "decision tree"

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TASK

SIS-11 Identifying pressure principles

PERFORMANCE OBJECTIVE

Identify the principles involved in pressurizing liquids and gases.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Properties of matter
b. Principles of liquid pressure
c. Units of pressure
d. Pressure and volume
e. Density and specific gravity
f. Gage pressure
g. Pressure and temperature
h. Atmosphere pressure
i. Flow and pressure
j. Pressure measurement indicating flow
k. Manometers

Provide Demonstration On:

a. Properties of matter
b. Units of measure
c. Environmental change and pressure
d. Measurement requirements
e. Measuring instruments

Provide Practical Application On:

a. Listing properties of matter
b. Describing results of changing environmental conditions
c. Listing measurement requirements

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

a. Kirk, Instrumentation
b. Fribance, Industrial Instrumentation Fundamentals
c. Stewart and Storer, Fluid Power

A/Vs:

Visual Aids Service, "Pressure Control Devices," movie-film

Student Manuals:

TPC, Instrumentation and Process Control, Pressure Measurement, Lesson One

Tools and Equipment:

a. Listing media
b. Pressure system trainer
c. Manometers

LAB HOURS	2
CLASS HOURS	1

EVALUATION (SIS-11)

a. Given necessary references and supplies, the student will list terms and symbols which describe the principles involved with pressurized liquids and gases. Responses must be at an accuracy level of 80%.

b. Fribance, Measurements Manual for Instrumentation and Applied Physics: Experiment 10, Time Constants Hydraulic and Pneumatic.

c. Neuschaefer, Industrial Process Control Program Manual of Experiment: Experiment B1, Pressure, Differential Pressure, Gages and Manometers.

INSTRUCTIONAL MATERIALS

Provide Practical Application On:

d. Listing measuring instruments used to monitor pressure
e. Applying low pressure to manometer

TASK

SIS-12 Identifying pressure sensors

PERFORMANCE OBJECTIVE

Identify the types of pressure sensors.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Types of sensors
    1. Bourdon tube
    2. Diaphragm
    3. Bellows
b. Bourdon tube shapes
c. Diaphragm
    1. Single
    2. Capsule
d. Sensor contacts
    1. Normally closed
    2. Activated closed
e. Using deadweight tester to calibrate pressure sensors

Provide Demonstration On:

a. Types of sensors
b. Data response of sensors
c. Methods of verifying serviceability
d. Use of deadweight tester

Provide Practical Application On:

a. Identifying types of sensors
b. Describing sensor output
c. Selecting calibration method and equipment
d. Operation of deadweight tester

INSTRUCTIONAL MATERIALS

Textbooks:

a. Fribance, Industrial Instrumentation Fundamentals
b. Stewart and Storer, Fluid Power

A/Vs:

a. ISA, "Density Measurement Methods - Hydrometer, Tranducers, Vibration Sensors, Densitometers," transparencies
b. DCA, "Pneumatic Gaging," transparencies

Student Manuals:

TPC, Instrumentation and Process Control, Pressure Measurement, Lesson Two

Tools and Equipment:

a. Listing media
b. Pressure sensors
c. Pressure system trainer
d. Deadweight tester

LAB HOURS	2
CLASS HOURS	1

EVALUATION (SIS-12)

a. Given necessary references and supplies, the student will list the terms and symbols which describe pressure sensors and their calibration equipment. Responses must be accurate to the 80% level.

b. Fribance, *Measurements Manual for Instrumentation and Applied Physics: Experiment 2, Pressure Measurement*.

c. Neuschaefer, *Industrial Process Control Program Manual of Experiment: Experiment B2, Receivers for Read-Out of Pressure, Indicators and Recorders*.

TASK

SIS-13 Identifying pressure transducers

PERFORMANCE OBJECTIVE

Identify the type of transducer and associated servicing method.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Conversion methods
b. Transducers
    1. Potentiometric
    2. Capacitive pressure
    3. Reluctance
    4. Reluctance pressure
    5. Servopressure
    6. Strain gage
    7. Piezoelectric
c. Methods of installation
d. Elements of periodic maintenance and repair
e. Transducer precautions

Provide Demonstration On:

a. Purpose of transducers
b. Types of transducers
c. Operation and maintenance of tranducers
d. Advantages of one over other for specific applications

Provide Practical Application On:

a. Identifying types of transducers
b. Identifying advantages of one type over others
c. Listing operational features by type

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INSTRUCTIONAL MATERIALS

Textbooks:

a. Considine, Process Instruments and Control Handbook
b. Fribance, Industrial Instrumentation Fundamentals
c. Johnson, Process Control Instrumentation Technology
d. Kirk, Instrumentation
e. Liptak, Instrument Engineer's Handbook
f. ISA, Basic Instrumentation Lecture Notes and Study Guide: Part 1, Measurement Fundamentals

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Student Manuals:

TPC, Instrumentation and Process Control, Pressure Measurement, Lesson Three

Tools and Equipment:

a. Listing media
b. Transducers, various types
c. Pressure system trainer
d. Transducer maintenance kit

LAB HOURS 2
CLASS HOURS 1

EVALUATION (SIS-13)

a. Given necessary references and supplies, the student will list the terms, symbols and maintenance procedures for various types of pressure transducers. Responses must be accurate to the 80% level or higher.

b. Fribance, Measurements Manual for Instrumentation and Applied Physics: Experiment 12, Basic Potentiometric Circuits.

c. Neuschaefer, Industrial Process Control Program Manual of Experiment: Experiment G4, The Potentiometer.

d. Neuschaefer, Industrial Process Control Program Manual of Experiment: Experiment J1, An Electrical to Pressure Transducer.

INSTRUCTIONAL ACTIVITIES

Provide Practical Application On:

d. Listing maintenance steps applicable to each type

INSTRUCTIONAL MATERIALS

Textbooks:

g. ISA, Standards and Practices for Instrumentation

TASK

SIS-14 Identifying low pressure measurement gage requirements

PERFORMANCE OBJECTIVE

Identify low pressure measurement gage requirements.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Vacuum
b. Low pressure
    1. Unit of measure, torr
    2. Methods of conversion
    3. Gages
c. Gages
    1. Thermal conductivity
    2. Pirani
    3. Thermocouple
    4. Slack diaphragm
    5. Ionization
    6. McLeod
    7. Capacitance manometer
d. Calculating pressure

Provide Demonstration On:

a. Types of gages
b. Operation of gages
c. Procedure for conversion of pressure in one scale to another scale

Provide Practical Application On:

a. Identifying requirements for low pressure measurement
b. Matching type of gage to specific requirements
c. Identifying operating principle of
    1. Thermal conductivity gages
    2. Ionization gages
    3. McLeod gages

INSTRUCTIONAL MATERIALS

Textbooks:

a. Considine, Process Instruments and Control Handbook
b. Fribance, Industrial Instrumentation Fundamentals
c. Johnson, Process Control
d. Kirk, Instrumentation
e. Liptak, Instrument Engineer's Handbook
f. ISA, Basic Instrumentation Lecture Notes and Study Guide: Part 1, Measurement Fundamentals

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Student Manuals:

TPC, Instrumentation and Process Control, Pressure Measurement, Lesson Four

Tools and Equipment:

a. Listing media
b. Gages (various types)

LAB HOURS 2

CLASS HOURS 1

EVALUATION (SIS-14)

Given necessary references and gages, the student will list the terms and symbols which identify low pressure gage requirements. Responses will be accurate to 80% level or higher.

INSTRUCTIONAL MATERIALS

Textbooks:

g. ISA, Standards and Practices for Instrumentation

TASK

SIS-15 Installing and servicing pressure instruments

PERFORMANCE OBJECTIVE

Install and service a pressure instrument.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Elements of pressure transmitters
b. Installation components
c. Installation procedures
d. Instrument maintenance
e. Instrument calibration
f. Troubleshooting
g. Repair procedures
h. Safety and equipment precaution during servicing

Provide Demonstration On:

a. Parts of transducer
b. Components of pressure transmitter
c. Elements of periodic maintenance
d. Techniques of troubleshooting and repair
e. Safety and precautions

Provide Practical Application On:

a. Identifying parts of pressure instruments
b. Identifying components of pressure transmitters

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INSTRUCTIONAL MATERIALS

Textbooks:

a. Kirk, Instrumentation
b. Fribance, Industrial Instrumentation Fundamentals
c. Stewart and Storer, Fluid Power

Student Manuals:

TPC, Instrumentation and Process Control, Pressure Measurement, Lesson Five

Tools and Equipment:

a. Listing media
b. Pressure instruments trainer
c. Calibration instruments
d. Instrument installation kit

LAB HOURS 3
CLASS HOURS 2

EVALUATION (SIS-15)

a. Given necessary references and supplies, the student will list the terms and symbols which identify instrument installation and servicing procedures. Responses will be accurate to 80% level or higher.

b. Fribance, Measurements Manual for Instrumentation and Applied Physics: Experiment 3, Pneumatic Pressure Transmitters.

c. Neuschaefer, Industrial Process Control Program Manual of Experiment: Experiment F-1, Calibration of a 0-15 P.S.I.

d. Neuschafer, Industrial Process Control Program Manual of Experiment: Experiment F-2, Calibration of a 0-10 P.S.I. Pressure.

INSTRUCTIONAL ACTIVITIES

Provide Practical Application On:

c. Identifying piping and installation requirements
d. Describing elements of periodic maintenance
e. Describing troubleshooting and repair techniques
f. Calibration of instruments rule and equipment
g. Stating safety handling precautions

TASK

SIS-16 Identifying force, stress and strain measurement units

PERFORMANCE OBJECTIVE

Identify force, stress and strain measurement units.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Force units
b. Static forces
c. Strain gages
d. System for measuring strain
e. Gage design
f. Application of gages
g. Force measuring devices
h. Piezoelectric effect

Provide Demonstration On:

a. Deriving units to measure force, stress and strain
b. Examples of gages
c. Application of piezoelectric effect
d. Methods of signal conditioning

Provide Practical Application On:

a. Identifying units of measure for force, stress and strain
b. Examination of gages used to monitor force, stress and strain

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INSTRUCTIONAL MATERIALS

Textbooks:

a. ISA, Standards and Practices For Instrumentation
b. Liptak, Instrument Engineer's Handbook

A/V's

Visual Aids Service "Mechanics, Lesson 7: Falling Bodies," movie film

(Continued on back)

Student Manuals:

TPC, Instrumentation and Process Control, Force, Weight, and Motion Measurement, Lesson One

Tools and Equipment:

a. Listing media
b. Examples of force, strain and stress gages

LAB HOURS	1
CLASS HOURS	3

EVALUATION (SIS-16)

Given necessary references and examples of gages, the student will identify the measurement units each gage monitors. Responses must be 80% correct or higher.

INSTRUCTIONAL ACTIVITIES

Provide Practical Application On:

c. Matching gage to specific application
d. Identifying limitations

INSTRUCTIONAL MATERIALS

A/Vs:

b. Visual Aids Service, "Mechanics, Lesson 9: Newton's First Law of Motion," movie film
c. Visual Aids Service, "Mechanics, Lesson 20: Parallel Forces," movie film

TASK

SIS-17 Identifying weight and mass measuring instruments

PERFORMANCE OBJECTIVE

Identify the proper weight or mass measuring instrument for a specific application.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Weight
b. Mass
c. Acceleration
d. Standardized units
    1. Mass
    2. Weight
e. Measuring instruments
    1. Weight
    2. Mass
f. Read out system
g. Recording system

Provide Demonstration On:

a. Comparision of mass and weight
b. Derivation of measuring units
c. Various mechanical and tension principles used in measuring instruments
d. In-line batch process scales

Provide Practical Application On:

a. Identifying weight measuring requirements
b. Identifying mass measuring requirements

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

a. Considine, Process Instruments Control Handbook
b. Liptak, Instrument Engineer's Handbook

A/V's

ISA, "Basic Instrumentation Lecture Notes and Study Guide: Part 1, Measurement Fundamentals," slide/tape

Student Manuals:

TPC, Instrumentation and Process Control, Force, Weight and Motion Measurement, Lesson Two

Tools and Equipment:

a. Listing media
b. Weight measuring instruments

(Continued on back)

LAB HOURS ☐

CLASS HOURS ☐

EVALUATION (SIS-17)

Given necessary references and examples of weighing instruments, the student will identify the correct instruments for a specific application. Responses must be 80% correct or higher.

INSTRUCTIONAL ACTIVITIES

Provide Practical Application On:

c. Weight and mass measuring instruments
d. Identifying in-line batch measuring requirements
e. Identifying read out and recording requirements

INSTRUCTIONAL MATERIALS

Tools and Equipment:

1. Spring
2. Balance

c. Mass measuring instruments
d. Weight calibration kit

600

TASK

SIS-18 Identifying methods for weighing materials in motion

PERFORMANCE OBJECTIVE

Identify the method used to measure the weight of materials in motion.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Scale components
  1. In-transit scales
  2. Nuclear scales
b. Calibration procedures
c. Safety and equipment precautions
d. Weigh feeders

Provide Demonstration On:

a. Load cell for in-transit weighing
b. Function of belt scale
c. Operation and application of nuclear scale
d. Continuous weight feeders

Provide Practical Application On:

a. Identification of proper instruments for weighing materials in motion
b. Identification of calibration instruments used to verify weighing instruments

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

a. Considine, *Process Instruments and Control Handbook*
b. Fribance, *Industrial Instrumentation Fundamentals*
c. Johnson, *Process Control Instrumentation Technology*
d. Kirk, *Instrumentation*
e. Liptak, *Instrument Engineer's Handbook*

(Continued on back)

Student Manuals:

TPC, Instrumentation and Process Control, *Force, Weight and Motion Measurement, Lesson Three*

Tools and Equipment:

a. Listing media
b. Example of load cells
c. Checklist for calibration
d. Calibration standards

LAB HOURS 2
CLASS HOURS 1

EVALUATION (SIS-18)

Given necessary references and examples of weighing materials in motion, the student will identify the correct instrument for a specific requirement. Responses must be 80% correct or higher.

INSTRUCTIONAL ACTIVITIES

Provide Practical Application On:

c. Identification of safety and equipment precautions
d. Identification of weigh feeders

INSTRUCTIONAL MATERIALS

Textbooks:

f. ISA, Basic Instrumentation Lecture Notes and Study Guide: Part 1, Measurement Fundamentals and Standards and Practices for Instrumentation

TASK

SIS-19 Identifying displacement measurement methods

PERFORMANCE OBJECTIVE

Identify the method of displacement measurement which is required for a specific application.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Measurement method:
    1. Linear position
    2. Proximity detection
    3. Air gaging
    4. Inspection gaging
    5. Angular position
b. Transducers
c. Other gages

Provide Demonstration On:

a. Displacement measuring equipment
b. Components of sensors and gages
c. Matching a particular method to a specific application

Provide Practical Application On:

a. Identifying displacement measuring equipment
b. Identifying component parts of measurement equipment
c. Matching type of equipment to specific requirement

INSTRUCTIONAL MATERIALS

Textbooks:

a. Kirk, Instrumentation
b. Considine, Process Instruments and Control Handbook
c. Liptak, Instrument Engineer's Handbook

A/Vs:

TPC, Supervisor's Unit Guide, "Force, Weight and Motion Measurement," transparencies

Student Manuals:

TPC, Instrumentation And Process Control, Force, Weight and Motion Measurement, Lesson Four

Tools and Equipment:

a. Listing media
b. Examples of displacement measuring equipment

LAB HOURS 2

CLASS HOURS 1

EVALUATION (SIS-19)

Given necessary references and examples of displacement measuring equipment, the student will identify the method to be applied in each process measurement requirements. Responses must be 80% correct or higher.

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TASK

SIS-20 Identifying acceleration, vibration and shock measurement methods

PERFORMANCE OBJECTIVE

Identify the specific measurement method used for acceleration, vibration or shock measuring requirements.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Linear motion
b. Linear acceleration
c. Operation of an accelerometer
d. Angular velocity
e. Angular acceleration
f. Vibration
g. Balancing equipment

Provide Demonstration On:

a. Operation of accelerometers
b. LVDT
c. Potentiometric
d. Strain gage
e. Piezoelectric accelerometers

Provide Practical Application On:

a. Identifying accelerometer, vibration and shock equipment
b. Identifying components of equipment
c. Matching measuring equipment to process control application

INSTRUCTIONAL MATERIALS

Textbooks:

a. Considine, Process Instruments and Control Handbook
b. Liptak, Instrument Engineer's Handbook

A/Vs:

TPC, Supervisor's Unit Guide, "Force, Weight and Motion Measurement," transparencies

Student Manuals:

TPC, Instrumentation and Process Control, Force, Weight and Motion Measurement, Lesson Five

Tools and Equipment:

a. Listing media
b. Examples of accelerometers

LAB HOURS	2
CLASS HOURS	1

EVALUATION (SIS-20)

Given necessary references and examples of acceleration, vibration, and shock measuring equipment, the student will identify the method each uses in monitoring process control operations. Correct responses must be 80% or higher.

TASK

SIS-21 Identifying the properties of fluid flow measurement

PERFORMANCE OBJECTIVE

Identify the properties of fluid flow measurement.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Basic properties of fluids
b. Fluids in motion
c. Generating fluid flow
d. Indicating fluid flow
e. Restrictions to fluid flow

Provide Demonstration On:

a. Definitions of fluid flow, velocity, density, specific gravity, viscosity, flow rate
b. Factors restricting flow
c. Reynolds number

Provide Practical Application On:

a. Identification of terms and symbols used to describe fluid flow properties
b. Identification of measurements which monitor fluid flow

INSTRUCTIONAL MATERIALS

Textbooks:

a. Kirk, *Instrumentation*
b. Fribance, *Industrial Instrumentation Fundamentals*
c. Considine, *Process Instruments and Control Handbook*
d. Liptak, *Instrument Engineer's Handbook*
e. ISA, *Basic Instrumentation Lecture Notes and Study Guide: Part 1, Measurement Fundamentals*

(Continued on back)

Student Manuals:

TPC, Instrumentation and Process Control, *Flow Measurement 1, Lesson One*

Tools and Equipment:

Listing media

LAB HOURS 2

CLASS HOURS 1

EVALUATION (SIS-21)

a. Given necessary references and supplies, the student will identify the terms and symbols which describe the properties of fluid flow measurement. Responses will be at the 80% accuracy level.

b. Fribance, Measurements Manual for Instrumentation and Applied Physics: Experiment 5, Mechanical Flow Measurements.

INSTRUCTIONAL MATERIALS

Textbooks:

f. Stewart and Storer, Fluid Power

A/Vs:

ISA, "Basic Instrumentation Lecture Notes and Study Guide: Part 1, Measurement Fundamentals," slides

TASK

SIS-22 Identifying primary measuring devices for fluid flow

PERFORMANCE OBJECTIVE

Identify the optimum type of "primary" fluid flow measurement instrument for a specific application.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Primary measurement devices
b. Mathematics of pressure
c. Restricting head flow
d. Orifice plate
e. Mixed solid and fluid flow
f. Weep holes
g. Venturi tubes
h. Flow nozzel
i. Pipe taps
j. Pipe must be straight
k. System balance
l. Flow formulas
m. Other than water fluid flow

Provide Demonstration On:

a. Nomenclature of primary measuring devices
b. Venturi action considering
   1. Pressure
   2. Speed
   3. Density
c. Location of weep holes

Provide Practical Application On:

a. Identifying the factors that influence fluid flow measurement
b. Working pressure, speed and density problems

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

a. Kirk, *Instrumentation*
b. Fribance, *Industrial Instrumentation Fundamentals*
c. Considine, *Process Instruments and Control Handbook*
d. Liptak, *Instrument Engineer's Handbook*
e. ISA, *Basic Instrumentation Lecture Notes and Study Guide: Part 1, Measurement Fundamentals*

(Continued on back)

Student Manuals:

TCP, Instrumentation and Process Control, *Flow Measurement 1, Lesson Two*

Tools and Equipment:

a. Listing and sketching media
b. Examples of primary measuring devices

(Continued on back)

LAB HOURS 2

CLASS HOURS 1

EVALUATION (SIS-22)

a. Given necessary references and examples of primary measuring devices for fluid flow applications, the student will identify the optimum type for each requirement. Responses will be correct at least to the 80% level.

b. Fribance, Measurements Manual for Instrumentation and Applied Physics: Experiment 6, Flow Measurements (Mechanical) Elbows.

INSTRUCTIONAL ACTIVITIES	INSTRUCTIONAL MATERIALS
Provide Practical Application On:	Textbooks:
c. Examination of various primary fluid flow measuring devices	f. Stewart and Storer, Fluid Power
d. Locating weep holes in orifice plates	Tools and Equipment:
e. Identifying venturi action under various conditions	c. Examples of orfice plates with weep hole drilled d. Examples of venturi

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TASK

SIS-23 Identifying secondary measuring devices for fluid flow

PERFORMANCE OBJECTIVE

Identify the optimum type of "secondary" fluid flow measurement for a specific application.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Secondary measuring devices
b. Differential measures
c. Operation of manometer
  1. Meniscus accuracy
  2. Wet type
  3. Dry type
  4. Mercury
d. Maintenance of mercury manometers
e. Calibration of manometers
f. Hazards of mercury
g. Other than mercury manometers
h. Delta transmitter
i. Target meter
j. Elbow mounting a measuring device
k. Pilot tube

Provide Demonstration On:

a. Secondary measuring devices
  1. Accuracy
  2. Reliability
b. Contrast inclined and U-tube manometers
c. Avoiding error readings while using mercury manometers

Provide Practical Application On:

a. Identifying type of "secondary" device for a specific application

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

a. Considine, Process Instruments and Control Handbook
b. Fribance, Industrial Instrumentation Fundamentals
c. Kirk, Instrumentation
d. Liptak, Instrument Engineer's Handbook
e. ISA, Basic Instrumentation Lecture Notes and Study Guide: Part 1, Measurement Fundamentals and Standards and Practices for Instrumentation

Student Manuals:

TPC, Instrumentation and Process Control, Flow Measurement 1, Lesson Three

Tools and Equipment:

a. Listing media
b. Examples of incline manometers

(Continued on back)

LAB HOURS 3
CLASS HOURS 1

EVALUATION (SIS-23)

a. Given necessary references and examples of secondary fluid flow measuring devices, the student will identify the optimum type for each application. Responses will be correct to at least the 80% level.

b. Fribance, Measurements Manual for Instrumentation and Applied Physics: Experiment 1, Manometers.

INSTRUCTIONAL ACTIVITIES

Provide Practical Application On:

b. Listing advantages and disadvantages of incline versus u-tube manometers
c. Developing correct techniques of reading manometers
d. Listing steps in maintenance of manometers

INSTRUCTIONAL MATERIALS

Tools and Equipment:

c. Examples of u-tube manometers
d. Manometer maintenance kit
e. Fluid flow system mock-up

TASK

SIS-24 Identifying applications for variable area instruments

PERFORMANCE OBJECTIVE

Identify the optimum variable area measuring instrument for a specific application.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Rotameter:
    1. Operation
    2. Reliability
    3. Maintenance
    4. Calibration
b. Measuring gas flow
c. Float shapes
d. Tube shapes
e. Range of application for rotameters
f. Changes in specific gravity of fluid on measurement data

Provide Demonstration On:

a. Contrast rotameter and orifice instrument
b. Scale differences between rotameter and orifice type
c. Factors affecting measurement
d. Conversion of units of measure area/volume

Provide Practical Application On:

a. Identification of rotameter
    1. Operation
    2. Factors governing reliability

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

a. Considine, Process Instruments and Control Handbook
b. Fribance, Industrial Instrumentation Fundamentals
c. Johnson, Process Control Instrumentation Technology
d. Kirk, Instrumentation
e. Liptak, Instrument Engineer's Handbook

(Continued on back)

Student Manuals:

TPC, Instrumentation and Process Control, Flow Measurement 1, Lesson Four

Tools and Equipment:

a. Listing media
b. Examples of rotameters
c. Examples of orifice type
d. Fluid flow mock-up
e. Fluids of different specific gravity lab

LAB HOURS 3

CLASS HOURS 1

EVALUATION (SIS-24)

Given necessary references and examples of rotameters for fluid flow applications, the student will select the optimum measuring device for each requirement. Responses must be correct to at least the 80% level.

INSTRUCTIONAL ACTIVITIES

Provide Practical Application On:

b. Computing gas flow
c. Conversion of area measurement to volume units and converse
c. Identifying applications for rotameter

INSTRUCTIONAL MATERIALS

Textbooks:

f. ISA, Basic Instrumentation Lecture Notes and Study Guide: Part 1, Measurement Fundamentals and Standards and Practices for Instrumentation

A/Vs:

ISA, "Basic Instrumentation Lecture Notes and Study Guide: Part 1, Measurement Fundamentals," slides

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TASK

SIS-25 Identifying open channel flow devices

PERFORMANCE OBJECTIVE

Identify the optimum open channel flow measuring instrument for a specific application.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Open channel flow
b. Weir
    1. Designs
    2. Uses
    3. Maintenance
    4. Calibration
    5. Precautions
c. Calculating flow rate
    1. Rectangular notch
        -Still water
        -Moving water
    2. Cippoletti notch
    3. V-shaped notch
d. Flumes
    1. Designs
    2. Uses
    3. Maintenance
    4. Calibration

(Continued on back)

Provide Demonstration On:

a. Weir structure and function
    1. Head
    2. Napper
    3. Steps in maintenance
    4. Components: notch, crest, pond, bulk head, head gage
b. Parshall flume structure and function
    1. Parts: crest, throat, stilling well, divergent section, converging section
    2. Maintenance

Provide Practical Application On:

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

a. Considine, Process Instruments and Control Handbook
b. Fribance, Industrial Instrumentation Fundamentals
c. Kirk, Instrumentation
d. Liptak, Instrument Engineer's Handbook
e. ISA, Basic Instrumentation Lecture Notes and Study Guide: Part 1, Measurement Fundamentals; Standards and Practices for Instrumentation

Student Manuals:

TPC, Instrumentation and Process Control, Flow Measurement 1, Lesson Five

Tools and Equipment:

a. Listing media
b. Descriptions of weir devices
c. Descriptions of flume devices

LAB HOURS 2

CLASS HOURS 1

EVALUATION (SIS-25)

Given necessary references and specifications of weir and flume measuring devices, the student will select the optimum instrument for specific applications. Correct responses will be at least 80% of total evaluation items used.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

5. Calculating flow rate
e. Estimating pipe discharge

Provide Practical Application On:

a. Identifying weir structure and function
b. Identifying flume structure and function
c. Identifying components of weir and flume measuring devices
d. Describing maintenance and calibration requirements for weir and flume devices

INSTRUCTIONAL MATERIALS

A/Vs:

ISA, "Basic Instrumentation Lecture Notes and Study Guide: Part 1, Measurement Fundamentals," slides

TASK

SIS-26 Identifying applications for positive displacement meters

PERFORMANCE OBJECTIVE

Identify the optimum positive displacement measuring instrument for a specific application.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Design and operation of positive displacement meters
   1. Piston
   2. Rotating vane
   3. Bellows
b. Advantages of one design over others for specific applications
c. Maintenance requirements
d. Calibration procedure and periodic scheduling

Provide Demonstration On:

a. Piston types: reciprocating oscillating
b. Sliding vane rotary meter
c. Nutating disk meter
d. Lobed impeller
e. Dry-gas bellows meter
f. Differences between target and positive displacement meters

Provide Practical Application On:

a. Identifying various types of positive displacement meters

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

a. Considine, Process Instruments and Control Handbook
b. Fribance, Industrial Instrumentation Fundamentals
c. Kirk, Instrumentation
d. Liptak, Instrument Engineer's Handbook
e. ISA, Basic Instrumentation Lecture Notes and Study Guide: Part 1, Measurement Fundamentals and Standards and Practices for Instrumentation

Student Manuals:

TPC, Instrumentation and Process Control, Flow Measurement II, Lesson One

Tools and Equipment:

a. Listing media
b. Examples of devices:
   1. Piston
   2. Rotating vane
   3. Bellows

(Continued on back)

LAB HOURS 3

CLASS HOURS 1

EVALUATION (SIS-26)

a. Given necessary references and examples of positive displacement meters, the student will select the optimum device for specific applications. Correct responses will be a minimum of 80% of all evaluation items.

b. TPC, Flow Measurement II, page 3.

INSTRUCTIONAL ACTIVITIES

Provide Practical Application On:

b. Describing maintenance requirements
c. Identifying calibration methods and suggested schedule for verifying condition
d. Selecting a type of positive displacement meter for a specific application

INSTRUCTIONAL MATERIALS

A/Vs:

Visual Aids Service, "Fluids in Motion," movie

Tools and Equipment:

c. Fluid flow mock-up
d. Calibrating equipment

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TASK

SIS-27 Identifying applications for turbine and magnetic flow meters

PERFORMANCE OBJECTIVE

Identify the optimum turbine and magnetic flow meter for specific measurement applications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Turbine flow meter
    1. Components
    2. Operating principles
    3. Installation
    4. Maintenance
b. Magnetic flow meter
    1. Components
    2. Operating principles
    3. Installation
    4. Maintenance
c. Advantages of one type over another
    1. Accuracy
    2. Reliability
    3. Cost

Provide Demonstration On:

a. Operation of turbine flow meters and magnetic flow meters
b. Maintenance steps
c. Calibration procedure

Provide Practical Application On:

a. Operating systems containing turbine and magnetic flow meters
b. Describing installation procedures
c. Identifying a particular type of turbine or magnetic flow meter for a specific application

INSTRUCTIONAL MATERIALS

Textbooks:

a. Considine, *Process Instruments and Control Handbook*
b. Fribance, *Industrial Instrumentation Fundamentals*
c. Kirk, *Instrumentation*
d. Liptak, *Instrument Engineer's Handbook*
e. *ISA, Basic Instrumentation Lecture Notes and Study Guide: Part 1, Measurement Fundamentals*

(Continued on back)

Student Manuals:

TPC, Instrumentation and Process Control, *Flow Measurement II, Lesson Two*

Tools and Equipment:

a. Listing media
b. Examples of devices
    1. Turbine flow meters
    2. Magnetic flow meters
c. Fluid flow mock-up
d. Calibration equipment

LAB HOURS 3

CLASS HOURS 1

EVALUATION (SIS-27)

a. Given necessary references and examples of turbine and magnetic flow meters, the student will select the optimum device for specific applications. Correct responses will be a minimum of 80% of all evaluation items.

b. TPC, Flow Measurement II, page 3.

c. Fribance, Measurements Manual for Instrumentation and Applied Physics: Experiment 19, Turbine or Propeller Flow Meters.

INSTRUCTIONAL MATERIALS

A/Vs:

Visual Aids Service, "Fluids in Motion," movie

TASK

SIS-28 Identifying types of fluid flow meters

PERFORMANCE OBJECTIVE

Identify by type a specific fluid flow meter.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Vortex-precession meters
b. Vortex-shedding meters
c. Thermal flow meters
d. Heat-transfer meter
e. Hot-wire meter
f. Ultrasonic flow meter
    1. Doppler shift
    2. Beam deflection
    3. Frequency difference

Provide Demonstration On:

a. Example of various flow meters discussed in this unit
b. Matrix of characteristics of flow meters

Provide Practical Application On:

a. Identifying flow meter in this grouping by hands-on examination of various types
b. Matching specific types to particular application

INSTRUCTIONAL MATERIALS

Textbooks:

a. Considine, Process Instruments and Control Handbook
b. Fribance, Industrial Instrumentation Fundamentals
c. Kirk, Instrumentation
d. Liptak, Instrument Engineer's Handbook
e. ISA, Basic Instrumentation Lecture Notes and Study Guide: Part 1, Measurement Fundamentals and Standards and Practices for Instrumentation

Student Manuals:

TPC, Instrumentation and Process Control, Flow Measurement II, Lesson Three

Tools and Equipment:

a. Listing media
b. Examples of various types of flow meters in this group

LAB HOURS 2
CLASS HOURS 1

EVALUATION (SIS-28)

Given necessary references and examples of flow meters in this grouping, the student will select the optimum instrument for a specific application. Correct responses will be a minimum of 80% of all evaluation items.

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TASK

SIS-29 Identifying solid particles flow metering methods

PERFORMANCE OBJECTIVE

Identify measuring systems used to monitor flow of solid particles.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Measuring volumetric and mass flow rate of solids
b. Volumetric solids flow meter
c. Mass flow meter for solids
d. Belt type solid meters
e. Belt speed sensing
f. Signal processing
g. Constant weight measuring systems

Provide Demonstration On:

a. Equipment used for monitoring flow of solid particles
b. How solid particle flow metering systems operate
c. Maintenance and calibration procedures

Provide Practical Application On:

a. Hands-on examination of solid particle flow meter equipment
b. Identifying maintenance and calibration requirements for solid particle flow measuring systems

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

a. Considine, Process Instruments and Control Handbook
b. Fribance, Industrial Instrumentation Fundamentals
c. Liptak, Instrument Engineer's Handbook
d. ISA, Basic Instrumentation Lecture Notes and Study Guide: Part 1, Measurement Fundamentals and Standards and Practices for Instrumentation

Student Manuals:

TPC, Instrumentation and Process Control, Flow Measurement II, Lesson Four

Tools and Equipment:

a. Listing media
b. Examples of solid particle flow monitoring equipment

LAB HOURS 1

CLASS HOURS 2

EVALUATION (SIS-29)

Given necessary references and examples of solid particle flow meters, the student will identify the optimum components for a specific measurement requirement. Correct responses will be a minimum of 80% of all evaluation items.

INSTRUCTIONAL ACTIVITIES

Provide Practical Application On:

c. Identifying optimum system for a specific application

TASK

SIS-30 Installing and maintaining flow instruments

PERFORMANCE OBJECTIVE

Install and maintain a flow measuring instrument.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Flow monitoring systems components
b. Flow elements
c. Tap points
d. Piping and fittings
e. Valves
f. Delta P transmitters
g. Installation requirements
h. Level installations
i. Equipment precautions
j. Preventive maintenance
k. Calibration requirements
l. Safety during servicing

Provide Demonstration On:

a. Components for flow systems
b. Installation guidelines
c. Instrument calibration
d. Maintenance guidelines

Provide Practical Application On:

a. Identifying components for measuring flow rate
b. Installing flow metering devices
c. Describing maintenance procedures
d. Describing calibration procedures
e. Describing equipment servicing precautions and safety procedures

INSTRUCTIONAL MATERIALS

Textbooks:

a. Considine, Process Instruments and Control Handbook
b. Fribance, Industrial Instrumentation Fundamentals
c. Johnson, Process Control Instrumentation Technology
d. Kirk, Instrumentation
e. Liptak, Instrument Engineer's Handbook
f. ISA, Basic Instrumentation Lecture Notes and Study Guide: Part 1, Measurement Fundamentals and Standards and Practices for Instrumentation

Student Manuals:

TPC, Instrumentation and Process Control, Flow Measurement II, Lesson Five

Tools and Equipment:

a. Components of flow measuring system
b. Installation tools
c. Calibration equipment
d. Fluid flow mock up

LAB HOURS	1
CLASS HOURS	4

EVALUATION (SIS-30)

a. Given necessary references and components of a flow measuring system, the student will install and calibrate a flow meter in a fluid flow system. Performance of operating system must be within tolerances given in equipment specification.

b. TPC, Flow Measurement II, page 3.

INSTRUCTIONAL MATERIALS

A/Vs:

Visual Aids Service, "Fundamental Principles of Flow," movie

TASK

SIS-31 Identifying level measurement instruments

PERFORMANCE OBJECTIVE

Identify level measurement instruments.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Liquid level measurement
b. Surface sensing
c. Tank storage gages
d. Sight glasses
e. Magnetic gages
f. Buoyancy
g. Displacer gages
h. Level switches
    1. Mercury type
    2. High pressure tanks
    3. Photoelectric
    4. Magnetic reed
i. Multiple displacers and level switches

Provide Demonstration On:

a. Types of surface-sensing gages
b. Difference between continuous level and point level measurement
c. Effects of buoyance
d. Variations in shapes of displacer
e. Contrast various sensing switches

Provide Practical Application On:

a. Hands-on examination of sensing devices
b. Identifying differences between gages and sensing devices

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

a. Considine, Process Instruments and Control Handbook
b. Fribance, Industrial Instrumentation Fundamentals
c. Kirk, Instrumentation
d. Liptak, Instrument Engineer's Handbook
e. ISA, Basic Instrumentation Lecture Notes and Study Guide: Part 1, Measurement Fundamentals and Standards and Practices for Instrumentation

Student Manuals:

TPC, Instrumentation and Process Control, Level Measurement, Lesson One

Tools and Equipment:

a. Listing media
b. Examples of level measuring gages
c. Examples of level sensing switches

LAB HOURS 2

CLASS HOURS 1

EVALUATION (SIS-31)

Given necessary references and examples of level gages and switches, the student will identify the optimum instruments for specific applications. Correct responses must be at least 80% of the evaluation items.

INSTRUCTIONAL ACTIVITIES

Provide Practical Application On:

c. Identifying operating principles of gages
d. Identifying operating principles of level switches

INSTRUCTIONAL MATERIALS

A/Vs:

ISA, "Basic Instrumentation Lecture Notes and Study Guide: Part 1, Measurement Fundamentals," slides

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TASK

SIS-32 Identifying pressure head instruments

PERFORMANCE OBJECTIVE

Identify the equipment used for pressure head measurement.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Hydrostatic pressure
b. Specific gravity
c. Fluids under pressure
d. Instruments for measuring pressure head
    1. Air bellows
    2. U-tube manometers
    3. Air purge systems
    4. Liquid purge systems
    5. Force balance
    6. Diaphragm systems
e. Advantages of one over another

Provide Demonstration On:

a. Calculating hydrostatic pressure
b. Contrast between air bellows and air purge systems
c. U-tube manometer attached to tank
d. Analysis of force balance diaphragm system

Provide Practical Application On:

a. Hands-on examination of instruments used to measure head pressure
b. Calculating liquid level using mercury u-tube manometer

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

a. Considine, Process Instruments and Control Handbook
b. Fribance, Industrial Instrumentation Fundamentals
c. Kirk, Instrumentation
d. Liptak, Instrument Engineer's Handbook
e. ISA, Basic Instrumentation Lecture Notes and Study Guide: Part 1, Measurement Fundamentals and Standards and Practices for Instrumentation

Student Manuals:

TPC, Instrumentation and Process Control, Level Measurement, Lesson Two

Tools and Equipment:

a. Listing media
b. Examples of pressure head measuring instruments

LAB HOURS	2
CLASS HOURS	1

EVALUATION (SIS-32)

Given necessary references and examples of pressure head instruments, the student will identify the optimum system components for monitoring specific requirements. Correct responses must be at least 80% of the evaluation items.

INSTRUCTIONAL ACTIVITIES

Provide Practical Application On:

c. Identifying advantages of one instrument over other similar measuring devices

TASK

SIS-33 Identifying electrical methods for level measurement

PERFORMANCE OBJECTIVE

Identify an optimum electrical method for level measurement for a specific process control application.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Conductivity of medium being measured
b. Measuring using capacitance
    1. Probes
    2. Supporting electrical system
    3. Zero and span adjustments
c. Sonic level detectors
d. Radiation level detectors
e. Point level detectors

Provide Demonstration On:

a. Factor affecting conductivity of medium being measured
b. Plates with liquid as dielectric
c. Capacitance probe in dielectric liquid
d. Sonic and radiation level detectors

Provide Practical Application On:

a. Hands-on examination of electrical level measuring devices

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

a. Considine, Process Instruments and Control Handbook
b. Fribance, Industrial Instrumentation Fundamentals
c. Kirk, Instrumentation
d. Liptak, Instrument Engineer's Handbook
e. ISA, Basic Instrumentation Lecture Notes and Study Guide: Part 1, Measurement Fundamentals and Standards and Practices for Instrumentation

Student Manuals:

TPC, Instrumentation and Process Control, Level Measurement, Lesson Three

Tools and Equipment:

a. Listing media
b. Basic plates/liquid dielectric capacitance level indicator

(Continued on back)

LAB HOURS	2
CLASS HOURS	1

EVALUATION (SIS-33)

a. Given necessary references and examples of electrical methods level measuring instruments, the student will identify optimum types of specific applications. Correct responses must be at least 80% of the evaluation items.

b. Neuschaefer, Industrial Process Control Program Manual of Experiment: Experiment G3, Simulation of a Closed-Loop Control System.

INSTRUCTIONAL ACTIVITIES

Provide Practical Application On:

b. Identifying advantages of one type over other types when given installation requirements
c. Construct a capacitance level indicator
d. Adjust zero and span

INSTRUCTIONAL MATERIALS

Tools and Equipment:

c. Liquid storage tank with electrical level instruments having zero and span control
d. Examples of various types

TASK

SIS-34 Identifying solid level measuring systems

PERFORMANCE OBJECTIVE

Identify an optimum method for measuring the level of solid materials.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Determining level from weight
b. Using sonic methods
c. Using microwaves
d. Using capacitance
e. Automatic bin fillers
    1. Diaphragm switches
    2. Tilt switches
    3. Rotating paddle detectors
f. Nuclear gages

Provide Demonstration On:

a. Examples of process controls which use instruments to measure solid level
b. Computing level
c. Principle of rotating paddle detectors
d. Principle of various switches for control of automatic filling

Provide Practical Application On:

a. Hands-on examination of examples of solid materials level measuring instruments

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

a. Considine, Process Instruments and Control Handbook
b. Fribance, Industrial Instrumentation Fundamentals
c. Johnson, Process Control Instrumentation Technology
d. Kirk, Instrumentation
e. Liptak, Instrument Engineer's Handbook
f. ISA, Basic Instrumentation Lecture Notes and Study Guide: Part I, Measurement Fundamentals and Standards and Practices for Instrumentation

Student Manuals:

TPC, Instrumentation and Process Control, Level Measurement, Lesson Four

Tools and Equipment:

a. Listing media
b. Examples of solid materials level measuring equipment

LAB HOURS 3

CLASS HOURS 1

EVALUATION (SIS-34)

Given necessary references, supplies and examples of solid material level measuring instruments, the student will identify an optimum system for specific applications. Correct responses must be 80% of the evaluation items.

INSTRUCTIONAL ACTIVITIES

Provide Practical Application On:

b. Computing level when given output units of specific systems
c. Identifying the optimum instrument for a specific system
d. Identifying the components of an automatic filling system

TASK

SIS-35 Servicing level measuring instruments

PERFORMANCE OBJECTIVE

Service a level measuring system.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Periodic servicing
b. Maintenance scheduling
    1. Reports
    2. Safety permits
    3. Work permits
    4. Vessel entry permits
    5. Fire permits
    6. Work orders
c. On-site servicing
    1. Gage glasses
    2. Floats
    3. Pressure head gages
d. Shop servicing
e. Repair and calibration
    1. Pneumatic instruments
    2. Electronic instruments
f. Troubleshooting using flow diagrams

Provide Demonstration On:

a. Documentation of servicing
b. Review types of level measuring instruments
c. Identify calibration requirements
d. Advantages of in-shop servicing over on-site and visa-versa

Provide Practical Application On:

a. Examination of documents used to control and report servicing
b. Identifying purpose of each document

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

a. Considine, Process Instruments and Control Handbook
b. Fribance, Industrial Instrumentation Fundamentals
c. Johnson, Process Control Instrumentation Technology
d. Kirk, Instrumentation
e. Liptak, Instrument Engineer's Handbook
f. ISA, Basic Instrumentation Lecture Notes and Study Guide: Part 1, Measurement Fundamentals and Standards and Practices for Instrumentation

Student Manuals:

TPC, Instrumentation and Process Control, Level Measurement, Lesson Five

Tools and Equipment:

a. Examples of documents used for reporting and controlling servicing
b. Examples of various types of level measurement systems

LAB HOURS 4

CLASS HOURS 1

EVALUATION (SIS-35)

a. Given necessary references, supplies and examples of level measuring equipment, the student will service various systems. Instruments must conform to specifications upon completion of servicing with no errors in documentation.

b. Fribance, Measurements Manual for Instrumentation and Applied Physics: Experiment 4, Liquid Level Determination.

INSTRUCTIONAL ACTIVITIES

Provide Practical Application On:

c. Identifying calibration standards for specific instruments
d. Servicing a level measuring system

TASK

SIS-36 Identifying temperature measurement principles

PERFORMANCE OBJECTIVE

Identify the principles involved in temperature measurement.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Heat
b. Temperature measurement
    1. Fahrenheit
    2. Celsius
    3. Rankin
    4. Kelvin
c. Calibration
    1. Primary standards
    2. Secondary standards
d. Temperature measurement application
    1. Instruments
    2. Color change as indicators
    3. Melting point as indicators

Provide Demonstration On:

a. Definition of thermal energy
b. Comparing temperature
c. scales
c. Identifying primary and
d. secondary standards
d. Examples of temperature measuring instruments

Provide Practical Application On:

a. Identifying temperature scales
b. Identifying primary and secondary standards used for verifying temperature measuring instruments

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

a. Considine, *Process Instruments and Control Handbook*
b. Fribance, *Industrial Instrumentation Fundamentals*
c. Johnson, *Process Control Instrumentation Technology*
d. Kirk, *Instrumentation*
e. Liptak, *Instrument Engineer's Handbook*

(Continued on back)

Student Manuals:

TPC, Instrumentation and Process Control, *Temperature Measurement, Lesson One*

Tools and Equipment:

Listing media

LAB HOURS	2
CLASS HOURS	1

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EVALUATION (SIS-36)

a. Given necessary references, the student will identify the principles involved in the operation of temperature measuring equipment. Responses will be correct in at least 80% of the evaluation items used.

b. Fribance, Measurements Manual for Instrumentation and Applied Physics: Experiment 7, Temperature Measurements.

c. Fribance, Measurements Manual for Instrumentation and Applied Physics: Experiment 9, Time Constants - Thermac.

INSTRUCTIONAL MATERIALS

Textbooks:

f. ISA, Basic Instrumentation Lecture Notes and Study Guide: Part 1, Measurement Fundamentals and Standards and Practices for Instrumentation

A/Vs:

a. Bureau of Audio Visual Instruction, "Basic Theory of Heat, Part 1," movie film and "Basic Theory of Heat, Part 2," movie film

b. Visual Aids Service, "Heat and Temperature," movie film

INSTRUCTIONAL ACTIVITIES

Provide Practical Application On:

c. Identifying principles involved in temperature measurements

TASK

SIS-37 Identifying bimetallic and fluid-filled temperature measuring instruments

PERFORMANCE OBJECTIVE

Identify bimetallic and fluid-filled temperature indicating instruments.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Bimetallic thermometers
b. Liquid-in-glass thermometers
c. Types of thermometer bulbs
d. Capillary tubes
e. Bourdon tubes
f. Temperature transmitters for filled systems
g. Advantages of one over others for specific applications

Provide Demonstration On:

a. Physical characteristics and operation of bimetallic thermometers
b. How liquid-in-glass are constructed
c. Advantages of one type over others for specific applications

Provide Practical Application On:

a. Identifying various types of bimetallic and fluid-filled temperature measuring instruments
b. Listing the advantages of one type over others for a given requirement

INSTRUCTIONAL MATERIALS

Textbooks:

a. Considine, Process Instruments and Control Handbook
b. Fribance, Industrial Instrumentation Fundamentals
c. Kirk, Instrumentation
d. Liptak, Instrument Engineer's Handbook
e. ISA, Basic Instrumentation Lecture Notes and Study Guide: Part 1, Measurement Fundamentals and Standards and Practices for Instrumentation

Student Manuals:

TPC, Instrumentation and Process Control, Temperature Measurement, Lesson Two

Tools and Equipment:

Listing media

LAB HOURS 2
CLASS HOURS 1

EVALUATION (SIS-37)

Given necessary references and examples of bimetallic and fluid-filled temperature instruments, the student will identify the specific type and its intended application. Correct responses will be at least 80% of evaluation items used.

INSTRUCTIONAL MATERIALS

A/Vs:

ISA, "Basic Instrumentation
Lecture Notes and Study
Guide: Part 1, Measurement
Fundamentals," slides

TASK

SIS-38 Identifying instruments using electrical methods of measuring temperature

PERFORMANCE OBJECTIVE

Identify the appropriate electrical method for measuring temperature in a specific process control application.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Resistance thermometers
b. RTD bridge circuits
c. Lead wire error
d. RTD elements
e. Protective wells
f. Thermistors
g. Thermocouples
h. Compensation circuits
i. Advantages of one type over others for specific applications

Provide Demonstration On:

a. Electrical temperature measuring instruments
b. Components of systems
c. Variation in operation due to environment
d. Advantages of one type over others

Provide Practical Application On:

a. Hands-on examination of electrical methods temperature measuring instruments
b. Identifying specific type of instrument
c. Identifying the advantages of one type over other types for a specific measurement requirement

INSTRUCTIONAL MATERIALS

Textbooks:

a. Considine, Process Instruments and Control Handbook
b. Fribance, Industrial Instrumentation Fundamentals
c. Johnson, Process Control Instrumentation Technology
d. Kirk, Instrumentation
e. Liptak, Instrument Engineer's Handbook
f. ISA, Basic Instrumentation Lecture Notes and Study Guide: Part I, Measurement Fundamentals and Standards and Practices for Instrumentation

Student Manuals:

TPC, Instrumentation and Process Control, Temperature Measurement, Lesson Three

Tools and Equipment:

Listing media

LAB HOURS	2
CLASS HOURS	1

EVALUATION (SIS-38)

a. Given necessary references and examples of temperature measuring instruments using electrical methods, the student will identify the optimum type for specific applications. Correct responses will be at least 80% of evaluation items.

b. Fribance, *Measurements Manual for Instrumentation and Applied Physics: Experiment 21, Electrical Temperature Measurement-I.*

c. Fribance, *Measurements Manual for Instrumentation and Applied Physics: Experiment 22, Electrical Temperature Measurement-II.*

TASK

SIS-39 Identifying pyrometers

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PERFORMANCE OBJECTIVE

Identify the optimum type of pyrometer for a specific measurement requirement.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Molecular activity
b. Electromagnetic radiation
c. Wave length of radiated energy
d. Narrow band pyrometers
e. Manual optical pyrometers
f. Automatic optical pyrometers
g. Broad band pyrometers
h. Band pass pyrometers
i. Advantages of one type over others for a specific operational requirement

Provide Demonstration On:

a. Principles of non-contact thermal measurement
b. Characteristics of a black body
c. Classifying pyrometer by wave length
d. Contrasting optical and radiation pyrometers

Provide Practical Application On:

a. Hands-on examination of various types of pyrometers
b. Identifying characteristics of various types of pyrometers

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

a. Considine, Process Instruments and Control Handbook
b. Fribance, Industrial Instrumentation Fundamentals
c. Johnson, Process Control Instrumentation Technology
d. Kirk, Instrumentation
e. Liptak, Instrument Engineer's Handbook
f. ISA, Basic Instrumentation Lecture Notes and Study Guide: Part 1, Measurement Fundamentals and Standards and Practices for Instrumentation

Student Manuals:

TPC, Instrumentation and Process Control, Temperature Measurement, Lesson Four

Tools and Equipment:

a. Listing media
b. Examples of pyrometers
c. Temperature pile

LAB HOURS	2
CLASS HOURS	1

EVALUATION (SIS-39)

a. Given references and examples of pyrometers, the student will identify the optimum type of pyrometer for specific applications. Correct responses will be at least 80% of evaluation items.

b. Fribance, Measurements Manual for Instrumentation and Applied Physics: Experiment 23, Temperature Measurements, Radiation and Optical Methods.

INSTRUCTIONAL ACTIVITIES

Provide Practical Application On:

c. Identifying operating wave length of different types

d. Identifying the optimum instrument for a specific application

INSTRUCTIONAL MATERIALS

A/Vs:

a. Bureau of Audio Visual Instruction, "Heat as Radiant Energy," slides

b. Bureau of Audio Visual Instruction, "Very High Temperature," slides

TASK

SIS-40 Performing temperature measuring instrument maintenance and calibration

PERFORMANCE OBJECTIVE

Perform maintenance and calibration of temperature measuring equipment.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Primary calibration standards
b. Primary standard instruments
c. Secondary standard instruments
d. Inspection scheduling
e. Controlled environment
f. Using the triple-point bath
g. Fixed temperature references
h. Maintenance procedures
i. Calibration procedures

Provide Demonstration On:

a. Identification of primary, secondary and working standards for temperature measurement
b. Maintenance and calibration procedures
c. Use of triple-point bath

Provide Practical Application On:

a. Identification of temperature instrument maintenance procedures
b. Identification of calibration standards used to verify temperature measuring instruments

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

a. Considine, Process Instruments and Control Handbook
b. Fribance, Industrial Instrumentation Fundamentals
c. Johnson, Process Control Instrumentation Technology
d. Kirk, Instrumentation
e. Liptak, Instrument Engineer's Handbook

(Continued on back)

Student Manuals:

TPC, Instrumentation and Process Control, Temperature Measurement, Lesson Five

Tools and Equipment:

a. Maintenance procedures
b. Temperature measuring system mock-up
c. Primary, secondary and working temperature standards
d. Calibration procedures

LAB HOURS 4

CLASS HOURS 2

EVALUATION (SIS-40)

Given necessary references, supplies and examples of temperature measuring equipment, the student will service various systems. Instruments must conform to specification upon completion of servicing.

INSTRUCTIONAL ACTIVITIES

Provide Practical Application On:

c. Performing periodic servicing of temperature measuring instruments

INSTRUCTIONAL MATERIALS

Textbooks:

f. ISA, Basic Instrumentation Lecture Notes and Study Guide: Part 1, Measurement Fundamentals and Standards and Practices for Instrumentation

A/Vs:

ISA, "Basic Instrumentation Lecture Notes and Study Guide: Part 1, Measurement Fundamentals," slides

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TASK

SIS-41 Identifying final control elements in process loops

PERFORMANCE OBJECTIVE

Identify the elements of final control in process loops.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. The final control element
b. Activators
c. Feedback loops
d. Control variables
e. Effects of disturbances on performance
f. Electric control signals
g. Fluidic control signals

Provide Demonstration On:

a. Elements of final control
b. Characteristics of feedback loops
c. Variables and signals in
   1. Electric control systems
   2. Fluidic control systems

Provide Practical Application On:

a. Identifying the elements of final control in process loops
b. Identifying feedback loop characteristics

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

a. Considine, Process Instruments and Control Handbook
b. Fribance, Industrial Instrumentation Fundamentals
c. Kirk, Instrumentation
d. Liptak, Instrument Engineer's Handbook
e. ISA, Basic Instrumentation Lecture Notes and Study Guide: Part 1, Measurement Fundamentals and Standards and Practices for Instrumentation

Student Manuals:

TPC, Instrumentation and Process Control, Final Control Elements, Lesson One

Tools and Equipment:

Listing media

LAB HOURS 2
CLASS HOURS 1

EVALUATION (SIS-41)

Given necessary references, the student will identify the elements of final control in a process loop. Correct responses must be at least 80% of the evaluation items.

INSTRUCTIONAL ACTIVITIES

Provide Practical Application On:

c. Identify variables and signals in
    1. Electric control systems
    2. Fluidic control systems

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TASK

SIS-42 Identifying electric activators

PERFORMANCE OBJECTIVE

Identify the proper electric activator for a specific control requirement.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Solenoids
b. Solenoid-operated valves
c. Electric motors
d. Universal motors
e. AC motors:
    1. Three-phase induction
    2. Single-phase induction
f. Stepper motors
g. Relay systems

Provide Demonstration On:

a. Construction and operation of solenoids and solenoid operated valves
b. Compare various types of motors
c. Contrast solenoids, motors and relays

Provide Practical Application On:

a. Hands-on examination of electric activators
b. Identifying the characteristics of electric activators
c. Identifying the optimum electric activator for a specific application

INSTRUCTIONAL MATERIALS

Textbooks:

a. Considine, Process Instruments and Control Handbook
b. Fribance, Industrial Instrumentation Fundamentals
c. Kirk, Instrumentation
d. Liptak, Instrument Engineer's Handbook
e. ISA, Basic Instrumentation Lecture Notes and Study Guide: Part 1, Measurement Fundamentals and Standards and Practices for Instrumentation

Student Manuals:

TPC, Instrumentation and Process Control, Final Control Elements, Lesson Two

Tools and Equipment:

a. Listing media
b. Examples of electric activators

LAB HOURS 2

CLASS HOURS 1

EVALUATION (SIS-42)

Given references and examples of electric activators, the student will identify optimum activators for specific applications. Correct responses must be 80% of all evaluation items.

TASK

SIS-43 Identifying pneumatic and hydraulic activators

PERFORMANCE OBJECTIVE

Identify the optimum pneumatic and hydraulic activator for specific process control.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Effects of changing pressure
b. Relationship of pressure/volumn/temperature and their changes
c. Activators:
   1. Pneumatic
   2. Diaphragm
   3. Spring
   4. Springless
   5. Direct-acting
   6. Reverse-acting
   7. Piston
   8. Hydraulic
d. Maintenance of activators

Provide Demonstration On:

a. Effects of pressure, volume and temperature on gas
b. Various types of activators
c. Advantages of one type over others for specific application
d. Suggested maintenance procedures

Provide Practical Application On:

a. Hands-on examination of pneumatic and hydraulic activators

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

a. Considine, Process Instruments and Control Handbook
b. Fribance, Industrial Instrumentation Fundamentals
c. Johnson, Process Control Instrumentation Technology
d. Kirk, Instrumentation
e. Liptak, Instrument Engineer's Handbook
f. ISA, Basic Instrumentation Lecture Notes and Study Guide: Part 1, Measurement Fundamentals and Standards and Practices for Instrumentation

Student Manuals:

TPC Instrumentation and Process Control, Final Control Elements, Lesson Three

Tools and Equipment:

a. Listing media
b. Examples of pneumatic activators
c. Examples of hydraulic activators
d. Activator servicing instrutions

LAB HOURS 2
CLASS HOURS 1

EVALUATION (SIS-43)

a. Given references and examples of pneumatic and hydraulic activators, the student will identify the optimum activator for specific applications. Correct responses must be at least 80% of all items evaluated.

b. Fribance, Measurements Manual for Instrumentation and Applied Physics: Experiment 29, Characteristics of Commercial Pneumatic Components.

c. Neuschaefer, Industrial Process Control Program Manual of Experiment: Experiment B4, Activator for Final Element.

INSTRUCTIONAL ACTIVITIES

Provide Practical Application On:

b. Identifying characteristics of various types of activators
c. Identifying the optimum activator for a particular application

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TASK

SIS-44 Identifying control valves

PERFORMANCE OBJECTIVE

Identify the optimum control valve for a specific process control application.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Function of control valves
b. Components of control valves
c. Types of control valves
    1. Globe
    2. Cage
    3. Butterfly
    4. Ball
    5. Sliding gate
    6. Diaphragm
    7. Split body
d. Control valve characteristics
e. Selecting valves for a particular process control system

Provide Demonstration On:

a. Types of control valves
b. Components of control valves
c. Contrast characteristic differences
d. Define: inherent, raugeability, gain, and turndown
e. Identifying mechanical limitations

Provide Practical Application On:

a. Hands-on examination of different control valves
b. Identifying components of control valves

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

a. Considine, Process Instruments and Control Handbook
b. Fribance, Industrial Instrumentation Fundamentals
c. Kirk, Instrumentation
d. Liptak, Instrument Engineer's Handbook
e. ISA, Basic Instrumentation Lecture Notes and Study Guide: Part 1, Measurement Fundamentals and Standards and Practices for Instrumentation

Student Manuals:

TPC, Instrumentation and Process Control, Final Control Elements Lesson Four

Tools and Equipment:

a. Listing media
b. Examples of control valves

LAB HOURS	2
CLASS HOURS	1

EVALUATION (SIS-44)

Given necessary references and examples of control valves, the student will identify the optimum valve for specific applications. Correct responses must be at least 80% of the total evaluation items.

INSTRUCTIONAL ACTIVITIES

Provide Practical Application On:

c. Listing characteristics of control valves
d. Selecting the optimum control valve for a specific process control application

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TASK

SIS-45 Identifying control element applications

PERFORMANCE OBJECTIVE

Identify the control element applications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

- a. Feed water control systems
  - 1. Components
  - 2. Operation
  - 3. Maintenance
  - 4. Calibration
- b. Sequential control of valves
- c. Relay logic
- d. Automatic valve control
- e. Furnace control systems
- f. Turbine control systems
- g. System limit devices
  - 1. Throttle
  - 2. Governor
  - 3. Activators

Provide Demonstration On:

- a. Valve sequence in feedwater control system
- b. Functions of control and block valves
- c. Relay logic systems
- d. Role of fuel feed controllers
- e. Turbine generator hydraulic supply control

Provide Practical Application On:

- a. Listing valve sequence of feedwater control system
- b. Identifying purpose and operation of control and block valves

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

- a. Considine, Process Instruments and Control Hand book
- b. Fribance, Industrial Instrumentation Fundamentals
- c. Johnson, Process Control Instrumentation Technology
- d. Kirk, Instrumentation
- e. Liptak, Instrument Engineer's Handbook
- f. ISA, Basic Instrumentation Lecture Notes and Study Guide: Part I, Measurement Fundamentals and Standards and Practices Instrumentation

Student Manuals:

TPC, Instrumentation and Process Control, Final Control Elements Lesson Five

Tools and Equipment:

- a. Listing media
- b. Illustrations of components of feedwater, fuel and hydraulic control systems

LAB HOURS 2

CLASS HOURS 1

EVALUATION (SIS-45)

Given necessary references and data of process control elements, the student will identify the application or applications specific elements satisfy. Correct responses must be at least 80% of the evaluation items.

INSTRUCTIONAL ACTIVITIES

Provide Practical Application On:

c. Identifying components of fuel feed control system
d. Identifying components of hydraulic supply control system
e. Matching control element to application

TASK

SIS-46 Identifying on-site safety standards and maintenance practices

PERFORMANCE OBJECTIVE

Identify personnel safety procedures and equipment precautions for on-site instrumentation servicing.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Identifying hazards
b. Safety regulations
c. Employer responsibility
d. Employee responsibility
e. Government safety regulations
    1. Federal
    2. Local
f. Hazards
    1. Chemical
    2. Electrical
    3. Biological
    4. Radiation
    5. Mechanical
g. Equipment precautions

Provide Demonstration On:

a. Government safety programs
b. Employer safety programs
c. Reporting accidents
d. Personnel hazards
e. Equipment operating precautions

Provide Practical Application On:

a. Identifying safety needs for on-site servicing
b. Identifying employer and employee responsibilities
c. Distinguishing between personnel safety and equipment precautions
d. Identifying expected on-site hazards

INSTRUCTIONAL MATERIALS

Textbooks:

a. Boley, A Guide to Effective Industrial Safety
b. Considine, Process Instruments and Control Handbook
c. Liptak, Instrument Engineer's Handbook
d. ISA, Standards and Practices for Instrumentation
e. National Safety Control, Accident Prevention Manual for Industrial Operations

Student Manuals:

TPC, Instrumentation and Process Control, Safety, Calibration and Testing Procedures

Tools and Equipment:

Listing media

LAB HOURS	1
CLASS HOURS	5

EVALUATION (SIS-46)

Given necessary references, the student will identify on-site personnel safety hazards, accident prevention practices and equipment precautions. Correct responses must be at least 80% of all evaluation items.

INSTRUCTIONAL MATERIALS

A/Vs:

a. TPC, "Breathe Easy," slide/tape and filmstrip, "Save Our Skin," slide/tape and filmstrip, "The Preventable Disaster," slide/tape and filmstrip and "TOSCA, Toxic Substances Control Act of 1976," slide/tape and filmstrip
b. Bureau of Audio Visual Instruction, "Accident Investigation," movie film, and "Accidents Don't Happen," movie film

TASK

SIS-47 Identifying servicing requirements

PERFORMANCE OBJECTIVE

Identify the operational requirements for performing instrumentation servicing.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Why instrument servicing
b. Requirements
  1. Maintenance
  2. Repair
  3. Calibration
c. Record keeping
d. The functional shop layout
e. Care of tools and equipment
f. Failure mode analysis
g. Instrumentation repair alternatives

Provide Demonstration On:

a. Establishing work routines which provide for prompt and effective servicing
b. Review servicing requirements
c. Failure mode analysis
d. The documentation loop
e. An effective shop layout
  1. Administration
  2. Repair
  3. Calibration
  4. Decontamination

Provide Practical Application On:

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

a. Considine, Process Instruments and Control Handbook
b. Fribance, Industrial Instrumentation Fundamentals
c. Johnson, Process Control Instrumentation Technology
d. Kirk, Instrumentation
e. Liptak, Instrument Engineer's Handbook and
f. ISA, Basic Instrumentation Lecture Notes and Study Guide: Part I, Measurement Fundamentals and Standards and Practices for Instrumentation

Student Manuals:

TPC, Instrumentation and Process Control, Safety Calibration and Testing Procedures

Tools and Equipment:

a. Listing media
b. Examples of shop layouts
c. Examples of failure more analysic logic trees

LAB HOURS 2

CLASS HOURS 1

EVALUATION (SIS-47)

Given necessary references, the student will identify process control instrumentation servicing requirements. Correct responses must be 80% of evaluation items.

INSTRUCTIONAL ACTIVITIES

Provide Practical Application On:

a. Identifying requirements for establishing a servicing environment
b. Identifying repair alternatives
c. Identifying procedures of failure mode analysis

TASK

SIS-48 Detailing electrical and electronic stations

PERFORMANCE OBJECTIVE

Detail the requirements for electrical and electronic component servicing stations.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Test station equipment requirements
   1. Capability
   2. Test equipment
   3. Calibration standards
b. The physical plant
   1. Work area
   2. Storage area
   3. Furnishings
   4. Power requirements
c. Administrative control
   1. Work load control
   2. Quality control
   3. Historical records

Provide Demonstration On:

a. Types of test equipment needed
b. Types of standards needed
c. Layout of physical plant
d. Power capability and stability
e. Use of mock-ups for system component testing

Provide Practical Application On:

a. Detailing test station requirements
b. Detailing the physical plant
c. Detailing administrative controls

(Continued on back)

INSTRUCTIONAL MATERIALS

Student Manuals:

TPC, Instrumentation and Process Control, Safety, Calibration and Testing Procedures, Lesson Three

Tools and Equipment:

a. Listing media
b. Equipment specifications
c. Standards specifications
d. Catalogs of office and ship equipment and supplies

LAB HOURS	3
CLASS HOURS	1

EVALUATION (SIS-48)

Given necessary references, the student will detail requirements for electrical and electronic instrumentation servicing station. Correct responses must be at least 80% of evaluation items.

INSTRUCTIONAL ACTIVITIES

Provide Practical Application On:

d. Detaling on-site operation and capability

TASK

SIS-49 Detailing pneumatic and hydraulic stations

PERFORMANCE OBJECTIVE

Detail the requirements for pneumatic and hydraulic component servicing stations.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Test station equipment requirements
    1. Capability
    2. Test equipment
    3. Calibration standards
b. Physical plant requirements
    1. Work area
    2. Storage area
    3. Furnishings
    4. Power requirements
        1. Air source
        2. Hydraulic
        3. Electrical
c. Administrative control
    1. Work load control
    2. Quality control
    3. Historical records

Provide Demonstration On:

a. Types of test equipment needed
b. Types of standards needed
c. Layout of the physical plant
d. Power requirements
e. Use of mock-ups for system component testing

Provide Practical Application On:

a. Detailing test station requirements
b. Detailing the physical plant
c. Detailing administrative controls
d. Detailing on-site operation and capability

INSTRUCTIONAL MATERIALS

Student Manuals:

TPC, Instrumentation and Process Control, *Safety, Calibration and Testing Procedures*, *Lesson Four*

Tools and Equipment:

a. Listing media
b. Equipment specifications
c. Standards specifications
d. Catalogs of office and shop equipment and supplies

LAB HOURS 3

CLASS HOURS 1

EVALUATION (SIS-49)

a. Given necessary references, the student will detail requirements for pneumatic and hydraulic instrumentation servicing station. Correct responses must be at least 80% of evaluation items.

b. Fribance, Measurements Manual For Instrumentation and Applied Physics: Experiment 30, Pneumatic Systems.

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TASK

SIS-50 Detailing troubleshooting requirements

PERFORMANCE OBJECTIVE

Detail troubleshooting requirements for in-shop and on-site servicing of process control instrumentation.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Data needed
   1. Manufacturer's literature
   2. Test equipment operation and service manuals
   3. Parts catalogs
   4. Standards operation and service manuals
   5. Tool catalogs
   6. Tests on troubleshooting techniques

b. Test equipment for signal tracing and signal substitution

c. Inspection aids

d. Developing historical records

Provide Demonstration On:

a. Starting with knowledge of system "working" parameters

b. Analyzing the missing or added difference from "normal" operation

c. Isolate to component or part

d. Making the repair or replacement decision
   1. Reviewing published data
   2. Reviewing historical records

Provide Practical Application On:

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

a. Considine, *Process Instruments and Control Handbook*

b. Fribance, *Industrial Instrumentation Fundamentals*

c. Johnson, *Process Control Instrumentation Technology*

d. Kirk, *Instrumentation*

e. Liptak, *Instrument Engineer's Handbook*

f. ISA, *Basic Instrumentation Lecture Notes and Study Guide: Part 1, Measurement Fundamentals* and *Standards and Practices for Instrumentation*

Student Manuals:

TPC, Instrumentation and Process Control, *Safety, Calibration and Testing Procedures, Lesson Five*

Tools and Equipment:

a. Listing media

b. Equipment catalogs

c. Tools catalogs

d. Servicing data

LAB HOURS 3

CLASS HOURS 1

EVALUATION (SIS-50)

Given necessary references, the student will detail process control instrumentation troubleshooting requirements. Correct responses must be at least 80% of evaluation items.

INSTRUCTIONAL ACTIVITIES

Provide Practical Application On:

a. Detailing data needs
b. Detailing troubleshooting testing equipment
c. Detailing inspection aids
d. Detailing troubleshooting procedures
    1. Using data flow charts
    2. Isolation techniques

TASK

DMS-01 Designing voltage amplifiers

PERFORMANCE OBJECTIVE

Design and build a voltage amplifier to specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Voltage amplifier design standards
b. Basic design rules
c. Limitations of a single design
d. Protoboarding and testing
e. Printed circuit layout

Provide Demonstration On:

a. How to sketch a basic design
b. How to set-up and test the design for stability and required voltage amplification

Provide Practical Application On:

Designing and building amplifier to specifications

INSTRUCTIONAL MATERIALS

Textbooks:

Rutkowski, Solid-State Electronics

Student Manuals:

Georgia, Electronics, Phase B, Unit 11-B

Tools and Equipment:

a. Power supply and protoboard
b. Parts for amplifier
c. Voltmeter, scope and signal source
d. Tools

LAB HOURS	15
CLASS HOURS	3

EVALUATION (DMS-01)

a. Given parts, equipment and specifications, the student will design and construct a voltage amplifier that will meet voltage and frequency response requirements.

b. Ohio, Communication Electronics, Performance Test Items.

TASK

DMS-02 Designing wave shaping circuits

PERFORMANCE OBJECTIVE

Design or modify an electronic wave shaping circuit.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Integrated RC networks
b. Differential networks
c. Filter action
d. Clipper action
e. Clamper action
f. Multivibrators

Provide Demonstration On:

a. How pulse circuits can be used to generate different wave forms
b. How RE filters, clippers and clampers can be used to modify shape of a wave form

Provide Practical Application On:

a. Making modifications to a given circuit to provide different wave forms
b. Designing a circuit to provide a specified wave form

INSTRUCTIONAL MATERIALS

Textbooks:

a. C.T.I., Electronic Circuits and Systems
b. McGraw-Hill, A Programmed Course in Basic Pulse Circuits

Student Manuals:

Georgia, Electronics Phase B, Unit 19-B

Tools and Equipment:

a. Signal source, meters, and scope
b. Parts and protoboard

LAB HOURS 15
CLASS HOURS 3

EVALUATION (DMS-02)

a. Given parts, equipment and specifications, the student will design and construct a test circuit that will provide the signal specified.

b. Ohio, Communication Electronics, Performance Test Items.

TASK

DMS-03 Designing logic circuits

PERFORMANCE OBJECTIVE

Design and construct a logic circuit to meet a required function.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Switching circuit theory
b. Boolean algebra
c. Logic handbook
d. Logic gates
e. Truth table implementation
f. All NAND/NOR logic designs

Provide Demonstration On:

a. How to construct a truth table for a logic function
b. How to write the Boolean expression for a logic circuit
c. How to simplify the expression
d. How to expand the expression for all NAND/NOR logic
e. How to build the circuit

Provide Practical Application On:

a. Construcing a truth table for a logic problem

(Continued on back)

INSTRUCTIONAL MATERIALS

Textbooks:

a. Tokheim, Digital Electronics
b. Heathkit, Digital Techniques

Student Manuals:

Georgia, Electronics, Phase B, Unit 20-B

Tools and Equipment:

Protoboard of trainers and parts

LAB HOURS 15

CLASS HOURS 3

EVALUATION (DMS-03)

a. Given parts, equipment and specifications, the student will construct a truth table, simplify the table, draw the required circuits and construct the circuit. The performance of the circuit must meet the instructor's specifications.

b. Ohio, Communication Electronics, Performance Test Items.

INSTRUCTIONAL ACTIVITIES

Provide Practical Application On:

b. Simplifying the truth table
c. Drawing the circuit
d. Building and testing the circuit

TASK

DMS-04 Modifying schematics

PERFORMANCE OBJECTIVE

Modify an existing circuit to meet new specifications.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. How to document circuit changes to an existing schematic
b. Examples of progessional schematic modifications

Provide Demonstration On:

a. How a change is made to a schematic diagram
b. How the change is documented

Provide Practical Application On:

Modifying an existing circuit to meet new specifications

INSTRUCTIONAL MATERIALS

Tools and Equipment:

a. Drafting tools and table
b. Schematic to be modified
c. Modification specifications

LAB HOURS 15
CLASS HOURS 3

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EVALUATION (DMS-04)

a. Given a schematic and specifications for change, the student will redraw the schematic to include the modification. Circuit performance must meet specifications.

b. V'TECS, Electronics Mechanics, Task No. C-10.

TASK

DMS-05 Laying out, taping up and drawing basic printed circuit boards

PERFORMANCE OBJECTIVE

Layout, tape up and/or draw basic printed circuit boards.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Schematic diagrams
b. Printed circuitry processes
c. Materials
d. Specifications
e. Conductor and components
    1. Conductor size
    2. Termination areas
    3. Specialized conductors in termination tapes
    4. Films and grids
    5. Tape application
    6. Tape and termination pad selection
f. Printed board design
g. Printed board layout
h. Component mounting

(Continued on back)

Provide Demonstration On:

Techniques for laying out, taping up and/or drawing printed circuit boards

Provide Practical Application On:

a. Drawing a PC board diagram
b. Laying out and taping up PC board

INSTRUCTIONAL MATERIALS

Textbooks:

a. Raskhodoff, Electronic Drafting and Design
b. Lindsey, The Design and Drafting of Printed Circuit Boards

Tools and Equipment:

a. Drafting kit
b. Dry transfer printed circuit board art work materials
c. Chartpak
d. Printed circuit board template

LAB HOURS	15
CLASS HOURS	3

EVALUATION (DMS-05)

a. Given a basic electronic schematic, reference data, printed circuit art work supplies and drafting supplies and equipment, the student will layout, tape up and/or draw the foil and component side art work necessary for fabricating a printed circuit board. The student must score a "B" or better on all items using the "Design Drafting Grading Sheet."

b. V'TECS, Electronics Mechanics, Task No. C-9.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

i. Integrated circuit grouping
j. Multi-layer printed circuit boards
k. Assembling drawings and parts layout
l. Designing reference information

TASK

DMS-06 Constructing printed circuit (PC) boards

PERFORMANCE OBJECTIVE

Layout and construct a specified printed circuit pattern on a PC board.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Types of PC board materials
b. Chemicals used in making PC board
c. Step-by-step procedure to make a PC board

Provide Demonstration On:

a. How to clean and prepare the PC board
b. How to layout the pattern
c. How to develop the pattern

Provide Practical Application On:

Preparing to develop and layout a PC board

INSTRUCTIONAL MATERIALS

Textbooks:

Lindsey, The Design and Drafting of Printed Circuit Boards

A/Vs:

Georgia, Electronics Technology, Phase A, "Printed Circuits," slide/tape

Student Manuals:

Georgia, Electronics, Phase B, Unit 25-B

Tools and Equipment:

a. PC board kit
b. Circuit to be made on PC board
c. Darkroom if photo kit is used

LAB HOURS	15
CLASS HOURS	3

EVALUATION (DMS-06)

a. Given the necessary materials to construct a PC board, the student will layout a specified circuit pattern and develop the finished PC board product. The student will install the components on the PC board and perform a proof of performance to prove the board will function 100% correctly.

b. V'TECS, Electronics Mechanics, Task No. E-14.

c. Ohio, Communication Electronics, Performance Test Items.

TASK

DMS-07 Modifying circuits to accommodate integrated circuits (IC)

PERFORMANCE OBJECTIVE

Substitute an intergrated circuit system in place of a discrete solid state system.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. IC chip systems
b. IC handbook of applications
c. Equivalent of one chip systems

Provide Demonstration On:

a. How to find an IC chip for a specific application
b. How to integrate the IC into a convential type circuit
c. How one chip can be used to replace many components

Provide Practical Application On:

Wiring an IC into a conventional circuit

INSTRUCTIONAL MATERIALS

Textbooks:

National, Linear Application Handbook; Digital Application Handbook

Tools and Equipment:

a. Discrete component type circuit
b. IC's and handbooks
c. Test meter, scope, signal generator
d. Power supply and protoboard

LAB HOURS 15

CLASS HOURS 3

EVALUATION (DMS-07)

a. Given circuit requirements and an IC application handbook, the student will locate and build an equivalent intergrated circuit. The circuit must meet specifications when tested.

b. V'TECS, Electronics Mechanics, Task No. C-11.

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TASK

DMS-07 Modifying circuits to accommodate integrated circuits (IC)

PERFORMANCE OBJECTIVE

Substitute an intergrated circuit system in place of a discrete solid state system.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. IC chip systems
b. IC handbook of applications
c. Equivalent of one chip systems

Provide Demonstration On:

a. How to find an IC chip for a specific application
b. How to integrate the IC into a convential type circuit
c. How one chip can be used to replace many components

Provide Practical Application On:

Wiring an IC into a conventional circuit

INSTRUCTIONAL MATERIALS

Textbooks:

National, Linear Application Handbook; Digital Application Handbook

Tools and Equipment:

a. Discrete component type circuit
b. IC's and handbooks
c. Test meter, scope, signal generator
d. Power supply and protoboard

LAB HOURS 15

CLASS HOURS 3

EVALUATION (DMS-07)

a. Given circuit requirements and an IC application handbook, the student will locate and build an equivalent intergrated circuit. The circuit must meet specifications when tested.

b. V'TECS, Electronics Mechanics, Task No. C-11.

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TASK

DMS-08 Preparing assembly guides

PERFORMANCE OBJECTIVE

Prepare a step-by-step assembly guide that can be used to build an electronic assembly.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Requirements for an assembly manual
b. A basic assembly manual
c. How to write an assembly manual

Provide Demonstration On:

a. How to use an assembly manual
b. How to go about writing an assembly manual

Provide Practical Application On:

Preparing an assembly guide on a simple wired electronic circuit

INSTRUCTIONAL MATERIALS

Tools and Equipment:

a. Pre-wired circuit
b. Paper and pencil
c. Parts and schematic
d. Samples of guides

LAB HOURS	15
CLASS HOURS	3

EVALUATION (DMS-08)

a. Given a pre-wired electronic assembly and parts to build an identical unit, the student will prepare a step-by-step assembly manual that can be used to assemble the unit to specifications.

b. V'TECS, Electronics Mechanics, Task No. C-13.

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TASK

DMS-09 Preparing parts lists

PERFORMANCE OBJECTIVE

Prepare a list of mechanical and electronic parts needed to construct an electronic project.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. Electronic master parts catalog
b. Manufacturer's parts catalog
c. Electronic supply houses
d. Parts substitution

Provide Demonstration On:

a. Locating electronic parts in a catalog
b. Locating mechanical parts in a manufacturer's catalog
c. Finding a dealer for parts not listed in catalogs
d. Parts substitution

Provide Practical Application On:

Preparing a parts list that would be needed to construct a given electronic circuit

INSTRUCTIONAL MATERIALS

Tools and Equipment:

a. Catalogs
b. Electronic assembly or schematic
c. Paper, pencil
d. Samples of parts lists

LAB HOURS 15
CLASS HOURS 3

EVALUATION (DMS-09)

a. Given an electronic chasis or schematic, the student will construct a parts list that will be sufficient to build the electronic system.

b. V'TECS, Electronics Mechanics, Task No. C-16.

TASK

DMS-10 Making truth tables for logic gates

PERFORMANCE OBJECTIVE

Produce a truth table for a 7400 TTL logic gate.

INSTRUCTIONAL ACTIVITIES

Provide Information On:

a. TTL Handbook
b. AND, OR, NOR, NAND GATE functions
c. Logic truth tables

Provide Demonstration On:

a. Setting up a logic chip gate for test
b. Setting up a truth table
c. Verifying the truth table with the handbook

INSTRUCTIONAL MATERIALS

Textbooks:

Texas Instruments, TTL Data Book

Student Manuals:

a. Georgia, Electronics Technology, Microcomputer Concepts, Units MC-1, MC-2 and MC-3
b. Georgia, Electronics, Phase B, Unit 20-B

Tools and Equipment:

a. 5 volt power supply
b. 7400 chips
c. Protoboard
d. Meter 260 or digital
e. Paper and pencil

LAB HOURS	15
CLASS HOURS	3

EVALUATION (DMS-10)

a. Given a 7400 chip, equipment and TTL handbook, the student will test the chip and produce a truth table that can be compared to the handbook for a good or bad decision.

b. Georgia, Microcomputer Concepts, Student Tests.

SECTION IV

CURRICULUM STRUCTURE, EXIT POINTS & COURSE OUTLINE

SECTION IV

Section IV Content List

Introduction to the Curriculum Structure
Curriculum Structure
  Group
  Individualized
Introduction to the Instrumentation Technology Exit Point
  Group
  Individualized
Introduction to the Course Outline
Course Outline

Section III presented a sample organizational model for sequencing the instruction of program tasks. Based on that model, Section IV provides suggested methods of structuring the entire Instrumentation Technology curriculum.

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INTRODUCTION TO THE CURRICULUM STRUCTURE

A curriculum structure is developed by sequencing duties into a logical teaching plan. Two curriculum structures are presented in this section - group and individualized.

The individualized structure also lists the duty areas, but does not include hours or quarters. Using the individualized approach, the student proceeds at his or her pace until each task is mastered.

In either type of structure, the duty areas can be rearranged to meet local needs.

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INSTRUMENTATION TECHNOLOGY SUGGESTED CURRICULUM STRUCTURE*

Course	Class Hours	Lab Hours	Total Hours
Quarter I			
Safety, procedures and tools	19	45	64
Blueprints, schematics and diagrams	24	116	140
Properties of materials	16	64	80
	59	225	284
Quarter II			
Manufacturing processes	61	221	282
	61	221	282
Quarter III			
Identification of test instruments	29	118	148
Physical properties measurement	12	7	18
DC measurement principles	60	30	90
	101	155	256
Quarter IV			
Low frequency measurement principles	18	33	51
High frequency measurement principles	48	81	129
Electrical equipment servicing	32	74	106
	98	188	286
Quarter V			
Direct current techniques	9	15	24
Low frequency techniques	15	24	39
High frequency techniques	30	90	120
Calibration of test instruments	30	90	120
	84	219	303
Quarter VI			
Servicing instrument systems	66	110	176
	66	110	176

Course	Class Hours	Lab Hours	Total Hours
Quarter VII			
Designing and modifying systems	30	150	180
	30	150	180
Total Program Hours	500	1262	1762

*This curriculum structure is designed to be used for group instruction.

INSTRUMENTATION TECHNOLOGY SUGGESTED CURRICULUM STRUCTURE*

Safety, procedures and tools
Blueprints, schematics and diagrams
Properties of materials
Manufacturing processed
Identification of test instruments
Physical properties measurement
DC measurement principles
Low frequency measurement principles
High frequency measurement principles
Electrical equipment servicing
Direct frequency techniques
High frequency techniques
Calibration of test instruments
Servicing instrument systems
Designing and modifying systems

*This curriculum structure is desinged to be used for individulized instruction.

INTRODUCTION TO INSTRUMENTATION TECHNOLOGY EXIT POINTS

The following diagrams illustrate points in the Instrumentation Technology program where a student should have acquired competencies necessary for entry level employment.

Both the group and individualized exit point diagrams sequence the Instrumentation Technology job classifications from least to most difficult. The group exit point diagram illustrates a lock-step process in which students proceed through an entire program at the same pace and exit at approximately the same point in time.

The individualized exit point diagram illustrates a self-paced progression through the Instrumentation Technology program. This approach permits a student to complete any one or all tasks necessary for entry level employment.

The major difference between the group and individualized approach is the number of tasks a student must master. For example, in the individualized approach, a student desiring employment as instrument mechanic needs to complete only those tasks identified for that job. However, in the group approach, a student must master the tasks in the previous DOT classifications leading to that particular job title.

Both diagrams are based on the preceeding suggested curriculum structures.

INSTRUMENTATION TECHNOLOGY
(Group Instruction)

Quarter I

710.381-042	Instrument Mechanic
710.381-046	Tester, Electronic Scale
710.384-014	Inspector
710.681-010	Assembler
710.681-014	Calibrator
710.684-030	Instrument Technician Helper
710.687-026	Instrument Checker

Quarter II

729.281-026	Electrical-Instrument Repairer

Quarter III

729.381-010	Electrical-Equipment Tester
710.381-038	Inspector, Mechanical and Electrical

Quarter IV

710.381-034	Inspector

Quarter V

019.281-010	Calibration Laboratory Technician

Quarter VI

710.281-030	Instrument Technician
710.281-026	Instrument Mechanic

Quarter VII

003.261-010	Instrumentation Technician
019.161-014	Test Technician

INSTRUMENTATION TECHNOLOGY
(Individualized Instruction)

710.684-030	Instrument Technician Helper
710.384-014	Inspector
710.381-042	Instrument Mechanic
710.381-046	Tester, Electronic Scale
710.687-026	Instrument Checker
710.681-014	Calibrator
710.681-010	Assembler
729.281-026	Electrical - Instrument Repairer
729.381-010	Electrical - Equipment Tester
710.381-038	Inspector, Mechanical and Electrical
710.381-034	Inspector
019.281-010	Calibration Laboratory Technician
710.281-026	Instrument Mechanic
710.281-030	Instrument Technician
019.161-014	Test Technician
003.261-010	Instrumentation Technician

INTRODUCTION TO THE COURSE OUTLINE

A course outline suggests a method of sequencing tasks for instruction. In the following outline, the unit guide tasks are ordered according to duty areas. The tasks are then arranged from general to specific knowledge and applications. The instructor is not restricted to using this specific outline, but may adapt it to meet his or her teaching needs.

The following course outline is designed for group instruction, however, it may be adapted for individualized instruction by eliminating the time sequencing for tasks.

INSTRUMENTATION TECHNOLOGY SUGGESTED COURSE OUTLINE

Quarter I

Task	Title	Class Hours	Lab Hours
	DUTY I: SAFETY, PROCEDURES AND TOOLS		
SPT-01	Identifying plant safety procedures	1	2
SPT-02	Observing safety precautions for tools and equipment	1	2
SPT-03	Identifying machinery safeguards	1	2
SPT-04	Observing safety in handling materials	1	2
SPT-05	Identifying work area safety precautions	1	2
SPT-06	Identifying fire prevention procedures	1	2
SPT-07	Handling hazardous materials	1	2
SPT-08	Observing electrical safety precautions	1	2
SPT-09	Identifying personal protection gear	1	2
SPT-10	Identifying and using hand tools	1	2
SPT-11	Identifying and using power tools	1	4
SPT-12	Identifying types of fasteners	1	1
SPT-13	Identifying and using wrenches and screwdrivers	1	2
SPT-14	Identifying and using pipefitting tools	1	2
SPT-15	Identifying and using plumbing tools	1	2
SPT-16	Identifying and using electrical tools	1	4
SPT-17	Identifying and using sheet metal tools	1	3
SPT-18	Identifying and using metal working tools	1	4
SPT-19	Identifying and using hoisting and pulling tools	1	3
		19	45
	DUTY II: BLUEPRINTS, SCHEMATICS AND DIAGRAMS		
BSD-01	Identifying basic principles of blueprint reading	1	2
BSD-02	Identifying elements of machine drawings	1	2
BSD-03	Identifying hydraulic and pneumatic drawings	1	4
BSD-04	Reading blueprint drawings	1	4
BSD-05	Reading electrical drawings	1	4
BSD-06	Reading pipe system drawings	1	3
BSD-07	Reading sheet metal drawings	1	4
BSD-08	Using shop math to interpret blueprints	1	4

		Class Hours	Lab Hours
BSD-09	Sketching schematic diagrams	1	4
BSD-10	Identifying types of schematics used in plant engineering	1	4
BSD-11	Identifying the symbols on electrical, piping and fluid power diagrams	1	3
BSD-12	Identifying guidelines for reading schematics	1	2
BSD-13	Identifying electrical symbols	1	2
BSD-14	Reading electrical diagrams	1	2
BSD-15	Identifying piping symbols	1	2
BSD-16	Reading piping schematics	1	2
BSD-17	Identifying fluid power symbols	1	3
BSD-18	Reading fluid power schematics	1	3
BSD-19	Identifying welding symbols	1	2
BSD-20	Drawing electrical one-line diagrams from engineering sketches	1	12
BSD-21	Drawing electrical elementary diagrams from engineering sketches	1	12
BSD-22	Drawing electronic schematic diagrams from engineering sketches	1	12
BSD-23	Preparing preliminary sketches	1	12
BSD-24	Drawing logic symbols	1	12
		24	116

DUTY III: PROPERTIES OF MATERIALS

		Class Hours	Lab Hours
POM-01	Identifying the physical structure of metals	1	4
POM-02	Identifying properties of metals	1	4
POM-03	Identifying non-metal materials	1	4
POM-04	Identifying properties and applications of carbon	1	4
POM-05	Identifying properties of rubber	1	4
POM-06	Identifying properties of industrial chemicals	1	4
POM-07	Identifying the properties of paints, coatings and their applications	1	4
POM-08	Identifying the properties of insulating materials and their applications	1	4
POM-09	Identifying properties and applications of construction materials	1	4
POM-10	Identifying properties and applications of wood	1	4
POM-11	Identifying adhesives and tapes	1	4
POM-12	Identifying basic principles of lubrication	1	4
POM-13	Identifying oils and their applications	1	4
POM-14	Identifying general purpose greases	1	4
POM-15	Identifying lubricating compounds	1	4

		Class Hours	Lab Hours
POM-16	Identifying hydraulic fluids	1	4
		16	64
Total Quarter I Class and Lab Hours		59	225
Total Quarter I Instructional Time		284	

Quarter II

Task	Title	Class Hours	Lab Hours
	DUTY IV: MANUFACTURING PROCESSES		
MFP-01	Identifying practical applications of power	1	2
MFP-02	Identifying pneumatic principles	1	3
MFP-03	Identifying reciprocating compressors	1	3
MFP-04	Identifying rotary compressors	1	3
MFP-05	Identifying primary air treatment in pneumatic systems	1	3
MFP-06	Identifying secondary air treatment methods	1	3
MFP-07	Identifying piping, hoses and fittings used in pneumatic systems	2	4
MFP-08	Identifying control valves	1	3
MFP-09	Identifying pressure relief valves	1	3
MFP-10	Identifying cylinders	1	3
MFP-11	Identifying motors	1	3
MFP-12	Identifying components of pneumatic systems	1	3
MFP-13	Reading pneumatic schematic drawings	1	3
MFP-14	Installing system components	1	4
MFP-15	Identifying procedures for pneumatic system maintenance	1	3
MFP-16	Determining system failures	1	5
MFP-17	Troubleshooting air compressors	1	5
MFP-18	Troubleshooting control valves	1	5
MFP-19	Troubleshooting cylinders	1	5
MFP-20	Troubleshooting air motors	1	5
MFP-21	Troubleshooting a pneumatic and hydraulic system	1	5
MFP-22	Identifying metal manufacturing processes	1	3
MFP-23	Identifying strainers and filters in hydraulic systems	1	3
MFP-24	Identifying reservoirs and accumulators in a hydraulic system	1	3
MFP-25	Identifying hydraulic pumps on a system	1	3
MFP-26	Identifying piping, tubing and fittings	1	3
MFP-27	Identifying directional control valves	1	3
MFP-28	Identifying pressure control valves	1	3
MFP-29	Identifying cylinders in a hydraulic system	1	3
MFP-30	Identifying hydraulic motors	1	3
MFP-31	Troubleshooting hydraulic systems schematics	1	5
MFP-32	Reading hydraulic schematic diagrams	1	3
MFP-33	Installing hydraulic components	1	5
MFP-34	Installing pipes and tubes	1	5
MFP-35	Selecting hydraulic fluids	1	5

		Class Hours	Lab Hours
MFP-36	Planning system maintenance	1	5
MFP-37	Troubleshooting hydraulic systems (diagnotic technique)	1	5
MFP-38	Troubleshooting valves	1	5
MFP-39	Troubleshooting cylinders	1	5
MFP-40	Troubleshooting pumps and motors	1	5
MFP-41	Identifying basic packaging methods	1	3
MFP-42	Identifying actuating mechanisms	1	3
MFP-43	Identifying basic troubleshooting principles of packaging machinery	1	9
MFP-44	Identifying mechanical drives	1	3
MFP-45	Identifying motors and brakes	2	8
MFP-46	Identifying electrical controls	1	5
MFP-47	Identifying packaging materials	1	3
MFP-48	Identifying methods of filling containers	1	3
MFP-49	Identifying methods of sealing	1	3
MFP-50	Identifying the processes used for heat treatment of materials	1	3
MFP-51	Identifying the processes used to produce plastics	1	3
MFP-52	Identifying the processes used to produce iron	1	3
MFP-53	Identifying processes used to produce steel	1	3
MFP-54	Identifying processes used to produce aluminum	1	3
MFP-55	Identifying processes for the production of magnesium	1	3
MFP-56	Identifying processes used to produce copper	1	3
MFP-57	Identifying processes used to produce lead, nickel, tin and zinc	1	3
MFP-58	Identifying common couplings	1	3
MFP-59	Identifying clutches	1	3
		61	221

Total Quarter II Class and Lab 61 221

Total Quarter II Instructional Time 282

Quarter III

Task	Title	Class Hours	Lab Hours
	DUTY V: IDENTIFICATION OF TEST INSTRUMENTS		
ITI-01	Identifying and using basic measuring instruments	1	3
ITI-02	Identifying and using volt-ohm milliammeters (VOM)	1	5
ITI-03	Identifying and using electronic voltmeters (EVM)		
ITI-04	Identifying and using ohmmeters	1	5
ITI-05	Identifying and using oscilloscopes	1	5
ITI-06	Identifying and using tube testers	1	5
ITI-07	Identifying and using transistor analyzers	1	5
ITI-08	Identifying and using capacitor testers	1	5
ITI-09	Identifying and using sine wave generators	1	5
ITI-10	Identifying and using signal generators	1	5
ITI-11	Identifying and using pulse generators	1	5
ITI-12	Identifying and using square wave generators	1	5
ITI-13	Identifying and using impedance testers	1	5
ITI-14	Identifying and using frequency meters	1	5
ITI-15	Using test instruments to measure voltage, current and resistance	1	5
ITI-16	Calculating values in DC network circuits	3	9
ITI-17	Calculating and measuring electrical values in AC capacitance	3	9
ITI-18	Measuring inductance in series RL circuits	3	9
ITI-19	Calculating capacitance and time constants for RC circuits	3	9
ITI-20	Measuring AC values for LF circuits	3	9
		29	118
	DUTY VI: PHYSICAL PROPERTIES MEASUREMENT		
PPM-01	Identifying the nature of force	2	1
PPM-02	Identifying physical properties of motion	2	1
PPM-03	Identifying principles of work and energy	2	1
PPM-04	Identifying principles of simple machines	2	1
PPM-05	Calculating area and volume	2	1
PPM-06	Identifying properties of friction	2	2
		12	7

		Class Hours	Lab Hours
	DUTY VII: DC MEASUREMENT PRINCIPLES		
DCM-01	Understanding fundamentals of electrical theory and electrical measurement	6	3
DCM-02	Making calculations using Ohm's law	6	3
DCM-03	Measuring current in DC circuits	6	3
DCM-04	Measuring voltage in DC circuits	6	3
DCM-05	Calculating and measuring resistance	6	3
DCM-06	Calculating voltage, current and resistance in DC series circuits	6	3
DCM-07	Calculating total voltage, total current and total resistance in DC parallel circuits	6	3
DCM-08	Calculating and measuring electrical quantities in combination DC circuits	6	3
DCM-09	Calculating power in DC circuits	6	3
DCM-10	Applying fundamentals of magnetism and electromagnetism	6	3
		60	30
Total Quarter III Class and Lab		101	155

Total Quarter III Instructional Time 256

Quarter IV

Task	Title	Class Hours	Lab Hours
	DUTY VIII: LOW FREQUENCY MEASUREMENT PRINCIPLES		
LFM-01	Calculating values of a right triangle	3	3
LFM-02	Identifying the characteristics of AC sine waves	3	3
LFM-03	Computing turns, voltage, current and impedance ratios of transformers	3	6
LFM-04	Determining reactance and impedance of a capacitor in either series of parallell	3	3
LFM-05	Drawing phasor diagrams and calculating operating values for series AC circuits	3	9
LFM-06	Drawing phasor diagrams and calculating operating values for parallel AC circuits	3	9
		18	33
	DUTY IX: HIGH FREQUENCY MEASUREMENT PRINCIPLES		
HFM-01	Understanding fundamentals of tuned AC circuits	3	3
HFM-02	Understanding fundamentals of semiconductor materials	3	9
HFM-03	Identifying symbols and electrical characteristics of tunnel, varacator and high frequency diodes	3	6
HFM-04	Understanding the fundamentals of bipolar transistors and their electrical characteristics	3	3
HFM-05	Performing condition tests of bipolar transistors	3	9
HFM-06	Understanding the fundamentals of field effect transistors and their electrical characteristics	3	3
HFM-07	Understanding the fundamentals of thyristors and their electrical characteristics	3	3
HFM-08	Understanding fundamentals of integrated circuits	3	9
HFM-09	Defining the operating values and applications of optoelectronic devices	3	3
HFM-10	Identifying the component parts and operational characteristics of diode vacuum tubes	3	3
HFM-11	Identifying the component parts and operating characteristics of triode vacuum tubes	3	3

		Class Hours	Lab Hours
HFM-12	Identifying the component parts and operating characteristics of tetrode vacuum tubes	3	3
HFM-13	Identifying the component parts and operating characteristics of pentode vacuum tubes	3	3
HFM-14	Performing condition testing of the thermal stability and operational parameters of a common-emitter amplifier circuit	3	9
HFM-15	Performing condition testing of DC and audio amplifiers	3	9
HFM-16	Defining electrical characteristics, applications and normal operational values of amplifiers	3	3
		48	81
	DUTY X: ELECTRICAL EQUIPMENT SERVICING		
EES-01	Performing a visual inspection of electronic equipment	4	6
EES-02	Cleaning electronic equipment	4	8
EES-03	Lubricating electronic equipment	3	3
EES-04	Inspecting and replacing power cords and distribution cables	3	6
EES-05	Inspecting and replacing vacuum tubes	3	6
EES-06	Inspecting and replacing transistors	3	9
EES-07	Inspecting and replacing IC units	3	9
EES-08	Inspecting and replacing printed circuit (PC) boards	3	9
EES-09	Performing a proof of performance on electronic equipment	3	9
EES-10	Keeping records on maintenance of equipment	3	9
		32	74
Total Quarter IV Class and Lab Hours		98	188
Total Quarter IV Instructional Time		286	

Quarter V

Task	Title	Class Hours	Lab Hours
	DUTY XI: DC TECHNIQUES		
DCT-01	Determining meter movement, sensitivity and resistance	2	4
DCT-02	Extending the current range of a meter movement	2	4
DCT-03	Extending the voltage range of a meter movement	2	4
DCT-04	Performing a condition test of a semiconductor diode using an ohmmeter	3	3
		9	15
	DUTY XII: LOW FREQUENCY TECHNIQUES		
LFT-01	Testing an amplifier for amplification	3	3
LFT-02	Testing and repairing the vacuum tube amplifier	3	3
LFT-03	Testing and repairing a transistor amplifier	3	9
LFT-04	Identifying component parts and electrical characteristics of power supply circuits	3	6
LFT-05	Testing and repairing power supplies	3	3
		15	24
	DUTY XIII: HIGH FREQUENCY TECHNIQUES		
HFT-01	Testing and repairing oscillators	3	9
HFT-02	Testing and repairing clampers	3	9
HFT-03	Testing and repairing clipper circuits	3	9
HFT-04	Testing and repairing counters	3	9
HFT-05	Constructing oscillators and performing a condition test of the oscillators	3	9
HFT-06	Constructing and performing condition tests of pulse circuits	3	9
HFT-07	Testing and repairing nonsinusoidal amplifiers	3	9
HFT-08	Troubleshooting sweep-generator circuits	3	9
HFT-09	Troubleshooting electronic circuits	3	9
HFT-10	Performing a condition test of zener diodes used in regulator circuits	3	9
		30	90

DUTY XIV: CALIBRATION OF TEST INSTRUMENTS

		Class Hours	Lab Hours
CTI-01	Performing condition test and calibration of volt-ohm-milliammeter (VOM)	3	9
CTI-02	Performing condition test and calibration of electrical voltmeters (VOM)	3	9
CTI-03	Performing condition test and calibration of tube testers	3	9
CTI-04	Performing condition test and calibration of a transistor tester	3	9
CTI-05	Performing condition test and calibration of resistor substitution box	3	9
CTI-06	Performing condition test and calibration of oscilloscopes	3	9
CTI-07	Performing condition test and calibration of sine wave generators	3	9
CTI-08	Performing condition test and calibration of square wave and pulse generators	3	9
CTI-09	Performing condition test and calibration of frequency meters	3	9
CTI-10	Calibrating power supply voltage	3	9
		30	90

Total Quarter V Class and Lab Hours	84	219
Total Quarter V Instructional Time	303	

Quarter VI

Task	Title	Class Hours	Lab Hours
	DUTY XV: SERVICING INSTRUMENT SYSTEMS		
SIS-01	Identifying automatic control system functions	1	2
SIS-02	Identifying the elements of process control	1	0
SIS-03	Identifying system transmitters and receivers process loops	2	0
SIS-04	Identifying diagram symbols and networks	1	2
SIS-05	Identifying parameters of an operational process control system	4	3
SIS-06	Identifying measurement purpose and requirements	1	1
SIS-07	Identifying the elements of measurement systems	1	1
SIS-08	Identifying measurement transducers	1	1
SIS-09	Identifying instrument calibration standards units	1	2
SIS-10	Analyzing systems using troubleshooting flow sheet	1	2
SIS-11	Identifying pressure principles	1	2
SIS-12	Identifying pressure sensors	1	2
SIS-13	Identifying pressure transducers	1	2
SIS-14	Identifying low pressure measurement gage requirements	1	2
SIS-15	Installing and servicing pressure instruments	2	3
SIS-16	Identifying force, stress and strain measurement units	3	1
SIS-17	Identifying weight and mass measuring instruments	1	2
SIS-18	Identifying methods for weighing materials in motion	1	2
SIS-19	Identifying displacement measurement methods	1	2
SIS-20	Identifying acceleration, vibration and shock measurement methods	1	2
SIS-21	Identifying the properties of fluid flow measurement	1	2
SIS-22	Identifying primary measuring devices for fluid flow	1	2
SIS-23	Identifying secondary measuring devices for fluid flow	1	3
SIS-24	Identifying applications for variable area instruments	1	3
SIS-25	Identifying open channel flow devices	1	2
SIS-26	Identifying applications for positive displacement meters	1	3
SIS-27	Identifying applications for turbine and magnetic flow meters	1	3
SIS-28	Identifying types of fluid flow meters	1	2

		Class Hours	Lab Hours
SIS-29	Identifying solid particles flow metering methods	2	1
SIS-30	Installing and maintaining flow instruments	4	7
SIS-31	Identifying level measurement instuments	1	2
SIS-32	Identifying pressure head instruments	1	2
SIS-33	Identifying electrical methods for level measurement	1	3
SIS-34	Identifying solid level measuring systems	1	3
SIS-35	Servicing level measuring instruments	1	4
SIS-36	Identifying temperature measurement principles	1	2
SIS-37	Identifying bimetallic and fluid-filled temperature measuring instruments	1	2
SIS-38	Identifying instruments using electrical methods of measuring temperature	1	2
SIS-39	Identifying pyrometers	1	2
SIS-40	Performing temperature measuring instrument maintenance and calibration	2	4
SIS-41	Identification of final control elements in process loops	1	2
SIS-42	Identifying electric activators	1	2
SIS-43	Identifying pneumatic and hydraulic activators	1	2
SIS-44	Identifying control values	1	2
SIS-45	Identifying control element applications	1	2
SIS-46	Identifying on-site safety standards and maintenance practices	5	1
SIS-47	Identifying servicing requirements	1	2
SIS-48	Detailing electrical and electronic stations	1	3
SIS-49	Detailing pneumatic and hydraulic stations	1	3
SIS-50	Detailing troubleshooting requirements	1	3
		66	110
Total Quarter VI Class and Lab Hours		66	110

Total Quarter VI Instructional Time 176

Quarter VII

Task	Title	Class Hours	Lab Hours
	DUTY XVI: DESIGNING AND MODIFYING SYSTEMS		
DMS-01	Designing voltage amplifiers	3	15
DMS-02	Designing wave shaping circuits	3	15
DMS-03	Designing logic circuits	3	15
DMS-04	Modifying schematics	3	15
DMS-05	Laying out, taping up and drawing basic printed circuit boards	3	15
DMS-06	Constructing printed circuit (PC) boards	3	15
DMS-07	Modifying circuits to accommodate integrated circuits (IC)	3	15
DMS-08	Preparing assembly guides	3	15
DMS-09	Preparing parts lists	3	15
DMS-10	Making truth tables for logic gates	3	15
		30	150
Total Quarter VII Class and Lab Hours		30	150

Total Quarter VII Instructional Time 180

SECTION V

RECORDS

SECTION V

Section V Content List

Individualized Competency Record
Group Progress Chart

Section V presents suggested ways of recording and documenting the progress of students through the curriculum. The recommended procedures include options for both individual and group records. The very important function of communicating the student's qualifications to potential employers is handled clearly and efficiently by the use of the Certificate of Competency, which is also described in this section.

RECORDS MANAGEMENT

This guide provides a series of easy to use documents that will aid the instructor in recordkeeping and that will be beneficial to the student in entering the work force.

In addition to providing the instructor with an "at a glance" assessment of individual and/or group progress, a Certificate of Competency, which can be used by students seeking employment, is included.

The group progress chart reflects individual task completion of all students. Due to confidentiality of records, grades must not be recorded on the chart. A notation indicating task completion (i.e., x or check) should be used.

INSTRUCTIONS

Instructions

Competency Checklist

1) Enter the student's name.
2) Enter the date and instructor's initials as each unit of instruction is completed.

The Competency Checklist automatically indicates when all the requirements for each DOT exit point or job title have been completed by the student. At each point on the certificate where an asterisk appears, the student is eligible to receive a Certificate of Competency.

Certificate of Competency

A Certificate of Competency is to be issued for each job title for which a student is qualified.

1) Enter the student's name.
2) Enter the school's name
3) Sign and date the form.

A Certificate of Competency may be issued at the time a student qualifies for it, or all certificates for which a student qualifies may be issued to the student when he/she completes or leaves the program.

Group Progress Chart

1) Enter all program tasks across top of matrix.
2) Enter the students' names down the left hand side of matrix.
3) As each student completes a task, a notation should be made in the square which corresponds with the task and the student's name.

COMPETENCY CHECKLIST

PROGRAM: INSTRUMENTATION TECHNOLOGY

STUDENT NAME:______________________________

				EXIT POINTS															
TASK NO.	UNIT COMPETENCIES	DATE	IN'T.	JOB TITLE: Instrumentation Technician DOT NO. 003.261-010	Test Technician 019.161-014	Calibration Laboratory Technician 019.281-010	Instrument Mechanic 710.281-026	Instrument Technician 710.281-030	Inspector 710.361-014	Inspector, Mechanical and Electrical 710.361-018	Instrument Mechanic 710.381-042	Tester, Electronic Scale 710.381-046	Inspector 710.384-014	Assembler 710.681-010	Calibrator 710.681-014	Instrument Technician Helper 710.684-030	Instrument Checker 710.687-026	Electrical - Instrument Repairer 729.281-026	Electrical-Equipment Tester 729.381-010
	SAFETY, PROCEDURES AND TOOLS																		
SPT-01	Identifying plant safety procedures			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPT-02	Observing safety precautions for tools and equipment			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPT-03	Identifying machinery safeguards			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPT-04	Observing safety in handling materials			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPT-05	Identifying work area safety precautions			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPT-06	Identifying fire prevention procedures			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPT-07	Handling hazardous materials			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPT-08	Observing electrical safety precautions			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPT-09	Identifying personal protection gear			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPT-10	Identifying and using hand tools			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPT-11	Identifying and using power tools			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPT-12	Identifying types of fasteners			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPT-13	Identifying and using wrenches and screwdrivers			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPT-14	Identifying and using pipefitting tools			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPT-15	Identifying and using plumbing tools			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPT-16	Identifying and using electrical tools			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPT-17	Identifying and using sheet metal tools			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPT-18	Identifying and using metalworking tools			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SPT-19	Identifying and using hoisting and pulling tools			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	BLUEPRINTS, SCHEMATICS AND DIAGRAMS																		
BSD-01	Identifying basic principles of blueprint reading			X	X	X	X	X	X	X		X	X	X	X		X	X	X
BSD-02	Identifying elements of machine drawing			X	X	X	X	X	X	X			X	X	X		X	X	X
BSD-03	Identifying hydraulic and pneumatic drawings			X						X									
BSD-04	Reading building drawings			X						X									
BSD-05	Reading electrical drawings			X						X				X	X		X	X	X
BSD-06	Reading pipe system drawings			X						X									
BSD-07	Reading sheet metal drawings			X						X									
BSD-08	Using shop math to interpret blueprints			X						X		X	X	X	X		X	X	X
BSD-09	Sketching schematic diagrams			X						X									
BSD-10	Identifying types of schematics used in plant engineering			X						X			X		X		X	X	X
BSD-11	Identifying the symbols on electrical piping and fluid power diagrams			X	X	X	X	X	X	X									
BSD-12	Identifying guidelines for reading schematics			X	X	X	X	X	X	X		X	X	X	X		X	X	X
BSD-13	Identifying electrical symbols			X	X	X	X	X	X	X									
BSD-14	Reading electrical diagrams			X	X	X	X	X	X	X				X	X		X	X	X
BSD-15	Identifying piping symbols			X	X	X	X	X	X	X									
BSD-16	Reading piping schematics			X	X	X	X	X	X	X									
BSD-17	Identifying fluid power symbols			X	X	X	X	X	X	X									
BSD-18	Reading fluid power schematics			X	X	X	X	X	X	X									
BSD-19	Identifying welding symbols			X	X	X	X	X	X	X									
BSD-20	Drawing electrical one-line diagrams from engineering sketches			X	X	X	X	X	X	X								X	
BSD-21	Drawing electrical elementary diagrams from engineering sketches			X	X	X	X	X	X	X								X	
BSD-22	Drawing electronic schematic diagrams from engineering sketches			X	X	X	X	X	X	X									
BSD-23	Preparing preliminary sketches			X	X	X	X	X	X	X									

COMPETENCY CHECKLIST

PROGRAM: INSTRUMENTATION TECHNOLOGY

STUDENT NAME:__________________________________

				EXIT POINTS															
				JOB TITLE Instrumentation Technician	Test Technician	Calibration Laboratory Technician	Instrument Mechanic	Instrument Technician	Inspector	Inspector, Mechanical and Electrical	Instrument Mechanic	Tester, Electronic Scale	Inspector	Assembler	Calibrator	Instrument Technician Helper	Instrument Checker	Electrical - Instrument Repairer	Electrical-Equipment Tester
TASK NO.	UNIT COMPETENCIES	DATE	IN'T.	DOT NO. 003.261-010	019.161-014	019.281-010	710.281-026	710.281-030	710.381-034	710.381-038	710.381-042	710.381-046	710.384-014	710.681-010	710.681-014	710.684-030	710.687-026	729.281-026	729.381-010
BSD-24	Drawing logic symbols			X	X	X	X	X	X	X									
	PROPERTIES OF MATERIALS																		
POM-01	Identifying the physical structure of metals			X	X	X	X	X	X	X			X	X	X		X	X	X
POM-02	Identifying properties of metals			X	X	X	X	X	X	X			X	X	X		X	X	X
POM-03	Identifying non-metal materials			X	X	X	X	X	X	X			X	X	X		X	X	X
POM-04	Identifying properties and applications of carbon			X	X	X	X	X	X	X			X	X	X		X	X	X
POM-05	Identifying properties of rubber			X	X	X	X	X	X	X			X	X	X		X	X	X
POM-06	Identifying properties of industrial chemicals			X	X	X	X	X	X	X			X	X	X		X	X	X
POM-07	Identifying the properties of paints, coatings and their applications			X	X	X	X	X	X	X			X	X	X		X	X	X
POM-08	Identifying the properties of insulating materials and their applications			X	X	X	X	X	X	X			X	X	X		X	X	X
POM-09	Identifying properties and applications of construction materials			X	X	X	X	X	X	X			X	X	X		X	X	X
POM-10	Identifying properties and applications of wood			X	X	X	X	X	X	X			X	X	X		X	X	X
POM-11	Identifying adhesives and tapes			X	X	X	X	X	X	X			X	X	X		X	X	X
POM-12	Identifying basic principles of lubrication			X	X	X	X	X	X	X			X	X	X		X	X	X
POM-13	Identifying oils and their applications			X	X	X	X	X	X	X			X	X	X		X	X	X
POM-14	Identifying general purpose greases			X	X	X	X	X	X	X			X	X	X		X	X	X
POM-15	Identifying lubricating compounds			X	X	X	X	X	X	X			X	X	X		X	X	X
POM-16	Identifying hydraulic fluids			X	X	X	X	X	X	X			X	X	X		X	X	X
	MANUFACTURING PROCESSES																		
MFP-01	Identifying practical applications of power			X	X														
MFP-02	Identifying pneumatic principles			X	X														
MFP-03	Identifying reciprocating compressors			X	X														
MFP-04	Identifying rotary compressors			X	X														
MFP-05	Identifying primary air treatment in pneumatic systems			X	X														
MFP-06	Identifying secondary air treatment methods			X	X														
MFP-07	Identifying piping, hoses and fittings used in pneumatic systems			X	X														
MFP-08	Identifying control valves			X	X														
MFP-09	Identifying pressure relief valves			X	X														
MFP-10	Identifying cylinders			X	X														
MFP-11	Identifying motors			X	X														
MFP-12	Identifying components of pneumatic systems			X	X														
MFP-13	Reading pneumatic schematic diagrams			X	X														
MFP-14	Installing system components			X	X														
MFP-15	Identifying procedures for pneumatic system maintenance																		
MFP-16	Determining system failures			X	X														
MFP-17	Troubleshooting air compressors			X	X														
MFP-18	Troubleshooting control valves			X	X														
MFP-19	Troubleshooting cylinders			X	X														
MFP-20	Troubleshooting air motors			X	X														
MFP-21	Troubleshooting a pneumatic and hydraulic system			X	X														
MFP-22	Identifying metal manufacturing processes			X	X														

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COMPETENCY CHECKLIST

PROGRAM: INSTRUMENTATION TECHNOLOGY

STUDENT NAME: ______________________________

TASK NO.	UNIT COMPETENCIES	DATE	IN'T.	EXIT POINTS — JOB TITLE / DOT NO.: Instrumentation Technician 003.261-010	Test Technician 019.161-014	Calibration Laboratory Technician 019.281-010	Instrument Mechanic 710.281-026	Instrument Technician 710.281-030	Inspector 710.381-034	Inspector, Mechanical and Electrical 710.381-038	Instrument Mechanic 710.381-042	Tester, Electronic Scale 710.381-046	Inspector 710.384-014	Assembler 710.681-010	Calibrator 710.681-014	Instrument Technician Helper 710.684-030	Instrument Checker 710.687-026	Electrical - Instrument Repairer 729.281-026	Electrical-Equipment Tester 729.381-010
MFP-23	Identifying strainers and filters in hydraulic systems			X	X														
MFP-24	Identifying reservoirs and accumulators in a hydraulic system			X	X														
MFP-25	Identifying hydraulic pumps on a system			X	X														
MFP-26	Identifying piping, tubing and fittings			X	X														
MFP-27	Identifying directional control valves			X	X														
MFP-28	Identifying pressure control valves			X	X														
MFP-29	Identifying cylinders in a hydraulic system			X	X														
MFP-30	Identifying hydraulic motors			X	X														
MFP-31	Troubleshooting hydraulic systems schematics			X	X														
MFP-32	Reading hydraulic schematic diagrams			X	X														
MFP-33	Installing hydraulic components			X	X														
MFP-34	Installing pipes and tubes			X	X														
MFP-35	Selecting hydraulic fluids			X	X														
MFP-36	Planning system maintenance			X	X														
MFP-37	Troubleshooting hydraulic systems (diagnostic technique)			X	X														
MFP-38	Troubleshooting valves			X	X														
MFP-39	Troubleshooting cylinders			X	X														
MFP-40	Troubleshooting pumps and motors			X	X														
MFP-41	Identifying basic packaging methods			X	X														
MFP-42	Identifying actuating mechanisms			X	X														
MFP-43	Identifying basic troubleshooting principles of packaging machinery			X	X														
MFP-44	Identifying mechanical drives			X	X														
MFP-45	Identifying motors and brakes			X	X														
MFP-46	Identifying electrical controls			X	X														
MFP-47	Identifying packaging materials			X	X														
MFP-48	Identifying methods of filling containers			X	X														
MFP-49	Identifying methods of sealing			X	X														
MFP-50	Identifying the processes used for heat treatment of material			X	X														
MFP-51	Identifying the processes used to produce plastics			X	X														
MFP-52	Identifying the processes used to produce iron			X	X														
MFP-53	Identifying processes used to produce steel			X	X														
MFP-54	Identifying processes used to produce aluminum			X	X														
MFP-55	Identifying processes for the production of magnesium and titanium			X	X														
MFP-56	Identifying processes used to produce copper			X	X														
MFP-57	Identifying processes used to produce lead, nickel, tin and zinc			X	X														
MFP-58	Identifying common couplings			X	X														
MFP-59	Identifying clutches			X	X														
	IDENTIFICATION OF TEST INSTRUMENTS																		
ITI-01	Identifying and using basic measuring instruments			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
ITI-02	Identifying and using volt-ohm milliammeters (VOM)			X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
ITI-03	Identifying and using electronic voltmeters (EVM)			X	X	X	X	X				X		X			X	X	X

COMPETENCY CHECKLIST

PROGRAM: INSTRUMENTATION TECHNOLOGY

STUDENT NAME:______________________________

				EXIT POINTS															
				JOB TITLE Instrumentation Technician	Test Technician	Calibration Laboratory Technician	Instrument Mechanic	Instrument Technician	Inspector	Inspector, Mechanical and Electrical	Instrument Mechanic	Tester, Electronic Scale	Inspector	Assembler	Calibrator	Instrument Technician Helper	Instrument Checker	Electrical - Instrument Repairer	Electrical-Equipment Tester
TASK NO.	UNIT COMPETENCIES	DATE	IN'T.	DOT NO. 003.261-010	019.161-014	019.281-010	710.281-026	710.281-030	710.381-034	710.381-038	710.381-042	710.381-046	710.384-014	710.681-010	710.681-014	710.684-030	710.687-036	729.281-026	729.381-010
ITI-04	Identifying and using ohmmeters			X	X	X	X	X	X	X	X	X	X	X	X	*X	X	X	X
ITI-05	Identifying and using oscilloscopes			X	X	X	X	X		X		X					X		X
ITI-06	Identifying and using tube testers			X	X	X	X	X											X
ITI-07	Identifying and using transistor analyzers			X	X	X	X	X											X
ITI-08	Identifying and using capacitor testers			X	X	X	X	X											X
ITI-09	Identifying and using sine wave generators			X	X	X	X	X							X		X		X
ITI-10	Identifying and using signal generators			X	X	X	X	X											X
ITI-11	Identifying and using pulse generators			X	X	X	X	X											X
ITI-12	Identifying and using square wave generators			X	X	X	X	X											X
ITI-13	Identifying and using impedance testers			X	X	X	X	X											
ITI-14	Identifying and using frequency meters			X	X	X	X	X											
ITI-15	Using test instruments to measure voltage, current and resistance			X	X	X	X	X				X		X			X	X	X
ITI-16	Calculating values in DC network circuits			X	X	X	X	X				X		X			X	X	X
ITI-17	Calculating and measuring electrical values in AC capacitance circuits			X	X	X	X	X											X
ITI-18	Measuring inductance in series RL circuits			X	X	X	X	X											X
ITI-19	Calculating capacitance and time constants for RC circuits			X	X	X	X	X											X
ITI-20	Measuring AC values for LF circuits			X	X	X	X	X											X
	PHYSICAL PROPERTIES MEASUREMENTS																		
PPM-01	Identifying the nature of force			X	X	X	X	X	X	X	X	X	X	X	X			X	X
PPM-02	Identifying physical properties of motion			X	X	X	X	X	X	X	X	X	X	X	X			X	X
PPM-03	Identifying principles of work and energy			X	X	X	X	X	X	X	X	X	X	X	X			X	X
PPM-04	Identifying principles of simple machines			X	X	X	X	X	X	X	X	X	X	X	X			X	X
PPM-05	Calculating area and volume			X	X	X	X	X	X	X	X	X	X	X	X			X	X
PPM-06	Identifying properties of friction			X	X	X	X	X	X	X	X	X	*X	X	X			X	X
	DC MEASUREMENT PRINCIPLES																		
DCM-01	Understanding fundamentals of electrical theory and electrical measurement			X	X	X	X	X	X	X	X	X		X				X	X
DCM-02	Making calculations using Ohm's law			X	X	X	X	X	X	X	X	X		X				X	X
DCM-03	Measuring current in DC circuits			X	X	X	X	X	X	X	X	X		X				X	X
DCM-04	Measuring voltage in DC circuits			X	X	X	X	X	X	X	X	X		X				X	X
DCM-05	Calculating and measuring resistance in DC circuits			X	X	X	X	X	X	X	X	X		X				X	X
DCM-06	Calculating voltage, current and resistance in DC series circuits			X	X	X	X	X	X	X	X	X		X				X	X
DCM-07	Calculating total voltage, total current and total resistance in DC parallel circuits			X	X	X	X	X	X	X	X	X		X				X	X
DCM-08	Calculating and measuring electrical quantities in combination DC circuits			X	X	X	X	X	X	X	X	X		X				X	X
DCM-09	Calculating power in DC circuits			X	X	X	X	X	X	X	X	X		X				X	X
DCM-10	Applying fundamentals of magnetism and electromagnetism			X	X	X	X	X	X	X	*X	*X		*X				X	X
	LOW FREQUENCY MEASUREMENTS																		
LFM-01	Calculating values for a right triangle			X	X	X	X	X	X	X					X		X	X	X

COMPETENCY CHECKLIST

PROGRAM: INSTRUMENTATION TECHNOLOGY

STUDENT NAME:________________________________

EXIT POINTS

TASK NO.	UNIT COMPETENCIES	DATE	IN'T.	JOB TITLE Instrumentation Technician	Test Technician	Calibration Laboratory Technician	Instrument Mechanic	Instrument Technician	Inspector	Inspector, Mechanical and Electrical	Instrument Mechanic	Tester, Electronic Scale	Inspector	Assembler	Calibrator	Instrument Technician Helper	Instrument Checker	Electrical - Instrument Repairer	Electrical-Equipment Tester
				DOT NO. 003.261-010	019.161-014	019.281-010	710.281-026	710.281-030	710.381-034	710.381-038	710.381-042	710.381-046	710.384-014	710.681-010	710.681-014	710.684-030	710.687-026	729.281-026	729.381-010
LFM-02	Identifying the characteristics of AC sine waves			X	X	X	X	X	X	X					X		X	X	X
LFM-03	Computing turns, voltage, current and impedance ratios of transformers			X	X	X	X	X	X	X								X	X
LFM-04	Determining reactance and impedance of a capacitor in either series or parallel circuits			X	X	X	X	X	X	X								X	X
LFM-05	Drawing phasor diagrams and calculating operating values for seires AC circuits			X	X	X	X	X	X	X								X	X
LFM-06	Drawing phasor diagrams and calculating operating values for parallel AC circuits			X	X	X	X	X	X	X								X	X
	HIGH FREQUENCY MEASUREMENT PRINCIPLES																		
HFM-01	Understanding fundamentals of tuned AC circuits			X	X	X	X	X											
HFM-02	Understanding fundamentals of semiconductor materials			X	X	X	X	X											
HFM-03	Identifying symbols and electrical characteristics of tunnel, varactor and high frequency diodes			X	X	X	X	X											
HFM-04	Understanding the fundamentals of bipolar transistors and their electrical characteristics			X	X	X	X	X											
HFM-05	Performing condition tests of bipolar transistors			X	X	X	X	X											
HFM-06	Understanding the fundamentals of field effect transistors and their electrical characteristics			X	X	X	X	X											
HFM-07	Understanding the fundamentals of thyristors and their electrical characteristics			X	X	X	X	X											
HFM-08	Understanding fundamentals of integrated circuits			X	X	X	X	X											
HFM-09	Defining the operating values and applications of opto-electronic devices			X	X	X	X	X											
HFM-10	Identifying the component parts and operational characteristics of diode vacuum tubes			X	X	X	X	X											
HFM-13	Identifying the component parts and operating parts and operating characteristics of pentode vacuum tubes			X	X	X	X	X											
HFM-14	Performing condition testing of the thermal stability and operational parameters of a common-emitter amplifier circuit			X	X	X	X	X											
HFM-15	Performing condition testing of DC and audio amplifiers			X	X	X	X	X											
HFM-16	Defining electrical characteristics, applications and normal operational values of amplifiers			X	X	X	X	X											
	ELECTRICAL EQUIPMENT SERVICING																		
EES-01	Performing a visual inspection of electronic equipment			X	X	X	X	X	X									X	X
EES-02	Cleaning electronic equipment			X	X	X	X	X	X									X	X
EES-03	Lubricating electronic equipment			X	X	X	X	X	X									X	X
EES-04	Inspecting and replacing power cords and distribution cables			X	X	X	X	X	X									X	X

COMPETENCY CHECKLIST

PROGRAM: INSTRUMENTATION TECHNOLOGY

STUDENT NAME:____________________________

EXIT POINTS

TASK NO.	UNIT COMPETENCIES	DATE	IN'T.	JOB TITLE Instrumentation Technician DOT NO. 003.261-010	Test Technician 019.161-014	Calibration Laboratory Technician 019.281-010	Instrument Mechanic 710.281-026	Instrument Technician 710.281-030	Inspector 710.381-034	Inspector, Mechanical and Electrical 710.381-038	Instrument Mechanic 710.381-042	Tester, Electronic Scale 710.381-046	Inspector 710.384-014	Assembler 710.681-010	Calibrator 710.681-014	Instrument Technician Helper 710.684-030	Instrument Checker 710.687-026	Electrical - Instrument Repairer 729.281-026	Electrical-Equipment Tester 729.381-010
EES-05	Inspecting and replacing vacuum tubes			X	X	X	X	X	X									X	X
EES-06	Inspecting and replacing transistors			X	X	X	X	X	X									X	X
EES-07	Inspecting and replacing IC units			X	X	X	X	X	X									X	X
EES-08	Inspecting and replacing printed circuit (PC) boards			X	X	X	X	X	X									X	X
EES-09	Performing a proof of performance on electronic equipment			X	X	X	X	X	X									X	X
EES-10	Keeping records on maintenance of equipment			X	X	X	X	X	X									X	X
	DC TECHNIQUES																		
DCT-01	Determining meter movement, sensitivity and resistance			X	X	X	X	X	X	X					X		X	X	X
DCT-02	Extending the current range of a meter movement			X	X	X	X	X	X	X					X		X	X	X
DCT-03	Extending the voltage range of a meter movement			X	X	X	X	X	X	X					X		X	X	X
DCT-04	Performing a condition test of a semiconductor diode using an ohmmeter			X	X	X	X	X	X	X					X		X	X	X
	LOW FREQUENCY TECHNIQUES																		
LFT-01	Testing an amplifier for amplification			X	X	X	X	X	X	X					X		X	X	X
LFT-02	Testing and repairing the vacuum tube amplifier			X	X	X	X	X	X	X					X		X	X	X
LFT-03	Testing and repairing a transistor amplifier			X	X	X	X	X	X	X					X		X	X	X
LFT-04	Identifying component parts and electrical characteristics of power supply circuits			X	X	X	X	X	X	X					X		X	X	X
LFT-05	Testing and repairing power supplies			X	X	X	X	X	*X	*X					*X		*X	*X	*X
	HIGH FREQUENCY TECHNIQUES																		
HFT-01	Testing and repairing oscillators			X	X	X	X	X											
HFT-02	Testing and repairing clampers			X	X	X	X	X											
HFT-03	Testing and repairing clipper circuits			X	X	X	X	X											
HFT-04	Testing and repairing counters			X	X	X	X	X											
HFT-05	Constructing oscillators and performing a condition test of the oscillators			X	X	X	X	X											
HFT-06	Constructing and performing condition tests of pulse circuits			X	X	X	X	X											
HFT-07	Testing and repairing non-sinusoidal amplifiers			X	X	X	X	X											
HFT-08	Troubleshooting sweep-generator circuits			X	X	X	X	X											
HFT-10	Performing a condition test of zener diodes used in regulator circuits			X	X	X	X	X											
	CALIBRATION OF TEST INSTRUMENTS																		
CTI-01	Performing condition test and calibration of volt-ohm milliammeter (VOM)			X		X	X	X											
CTI-02	Performing condition test and calibration of electrical voltmeters (EVM)			X		X	X	X											
CTI-03	Performing condition test and calibration of tube testers			X		X	X	X											
CTI-04	Performing condition test and calibration of a transistor tester			X		X	X	X											
CTI-05	Performing condition test and calibration of resistor substitution box			X		X	X	X											
CTI-06	Performing condition test and calibration of oscilloscopes			X		X	X	X											
CTI-07	Performing condition test and calibration of sine wave generators			X		X	X	X											

COMPETENCY CHECKLIST

PROGRAM: INSTRUMENTATION TECHNOLOGY

STUDENT NAME: ____________________

TASK NO.	UNIT COMPETENCIES	DATE	IN'T.	JOB TITLE / DOT NO.: Instrumentation Technician 003.261-010	Test Technician 019.161-014	Calibration Laboratory Technician 019.281-010	Instrument Mechanic 710.281-026	Instrument Technician 710.281-030	Inspector 710.381-034	Inspector, Mechanical and Electrical 710.381-038	Instrument Mechanic 710.381-042	Tester, Electronic Scale 710.381-046	Inspector 710.384-014	Assembler 710.681-010	Calibrator 710.681-014	Instrument Technician Helper 710.684-030	Instrument Checker 710.687-026	Electrical - Instrument Repairer 729.281-026	Electrical-Equipment Tester 729.381-010
CTI-08	Performing condition test and calibration of square wave and pulse generators			X		X	X	X											
CTI-09	Performing condition test and calibration of frequency meters			X		X	X	X											
CTI-10	Calibrating power supply voltage			X		*X	X	X											
	SERVICING INSTRUMENTATION SYSTEMS																		
SIS-01	Identifying automatic control system functions			X	X		X	X								X			
SIS-02	Identifying the elements of process control			X	X		X	X								X			
SIS-03	Identifying system transmitters and receivers process loops			X	X		X	X								X			
SIS-04	Identifying diagram symbols and networks			X	X		X	X								X			
SIS-05	Identifying parameters of an operational process control system			X	X		X	X								X			
SIS-06	Identifying measurement purpose and requirements			X	X		X	X								X			
SIS-07	Identifying the elements of measurement systems			X	X		X	X								X			
SIS-08	Identifying measurement transducers			X	X		X	X								X			
SIS-09	Identifying instrument calibration standards units			X	X		X	X								X			
SIS-10	Analyzing systems using troubleshooting flow sheet			X	X		X	X								X			
SIS-11	Identifying pressure principles			X	X		X	X											
SIS-12	Identifying pressure sensors			X	X		X	X											
SIS-13	Identifying pressure transducers			X	X		X	X											
SIS-14	Identifying low pressure measurement gage requirements			X	X		X	X											
SIS-15	Installing and servicing pressure instruments			X	X		X	X											
SIS-16	Identifying force, stress and strain measurement units			X	X		X	X											
SIS-17	Identifying weight and mass measuring instruments			X	X		X	X											
SIS-18	Identifying methods for weighing material in motion			X	X		X	X											
SIS-19	Identifying displacement measurement methods			X	X		X	X											
SIS-20	Identifying acceleration, vibration and shock measurement methods			X	X		X	X											
SIS-21	Identifying the properties of fluid flow measurement			X	X		X	X											
SIS-22	Identifying primary measuring devices for fluid flow			X	X		X	X											
SIS-23	Identifying secondary measuring devices for fluid flow			X	X		X	X											
SIS-24	Identifying applications for variable area instruments			X	X		X	X											
SIS-25	Identifying open channel flow devices			X	X		X	X											
SIS-26	Identifying applications for positive displacement meters			X	X		X	X											
SIS-27	Identifying applications for turbine and magnetic flow meters			X	X		X	X											
SIS-28	Identifying types of fluid flow meters			X	X		X	X											
SIS-29	Identifying solid particles flow metering methods			X	X		X	X											

COMPETENCY CHECKLIST

PROGRAM: INSTRUMENTATION TECHNOLOGY

STUDENT NAME:______________________________

TASK NO.	UNIT COMPETENCIES	DATE	IN'T.	Instrumentation Technician 003.261-010	Test Technician 019.161-014	Calibration Laboratory Technician 019.281-010	Instrument Mechanic 710.281-026	Instrument Technician 710.281-030	Inspector 710.381-034	Inspector, Mechanical and Electrical 710.381-038	Instrument Mechanic 710.381-042	Tester, Electronic Scale 710.381-046	Inspector 710.384-014	Assembler 710.681-010	Calibrator 710.681-014	Instrument Technician Helper 710.684-030	Instrument Checker 710.687-026	Electrical - Instrument Repairer 729.281-026	Electrical-Equipment Tester 729.381-010
				EXIT POINTS															
SIS-30	Installing and maintaining flow instruments			X	X		X	X											
SIS-31	Identifying level measurement instruments			X	X		X	X											
SIS-32	Identifying pressure head instruments			X	X		X	X											
SIS-33	Identifying electrical methods for level measurement			X	X		X	X											
SIS-34	Identifying solid level measuring systems			X	X		X	X											
SIS-35	Servicing level measuring instruments			X	X		X	X											
SIS-36	Identifying temperature measurement principles			X	X		X	X											
SIS-37	Identifying bimetallic and fluid filled temperature measuring instruments			X	X		X	X											
SIS-38	Identifying instruments using electrical methods of measuring temperature			X	X		X	X											
SIS-39	Identifying pyrometers			X	X		X	X											
SIS-40	Performing temperature measuring instrument maintenance and calibration			X	X		X	X											
SIS-41	Identification of final control elements in process loops			X	X		X	X											
SIS-42	Identifying electric activators			X	X		X	X											
SIS-43	Identifying pneumatic and hydraulic activators			X	X		X	X											
SIS-44	Identifying control valves			X	X		X	X											
SIS-45	Identifying control element applications			X	X		X	X											
SIS-46	Identifying on-site safety standards and maintenance practices			X	X		X												
SIS-47	Identifying servicing requirements			X	X		X												
SIS-48	Detailing electrical and electronic stations			X	X		X	X											
SIS-49	Detailing pneumatic and hydraulic stations			X	X		X	X											
SIS-50	Detailing troubleshooting requirements			X	X		X	X											

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COMPETENCY CHECKLIST

PROGRAM: INSTRUMENTATION TECHNOLOGY

STUDENT NAME:____________________________________

EXIT POINTS

	JOB TITLE			Instrumentation Technician	Test Technician	Calibration Laboratory Technician	Instrument Mechanic	Instrument Technician	Inspector	Inspector, Mechanical and Electrical	Instrument Mechanic	Tester, Electronic Scale	Inspector	Assembler	Calibrator	Instrument Technician Helper	Instrument Checker	Electrical - Instrument Repairer	Electrical-Equipment Tester
	DOT NO.			003.261-010	019.161-014	019.281-010	710.281-026	710.281-030	710.381-034	710.381-038	710.381-042	710.381-046	710.384-014	710.681-010	710.681-014	710.684-030	710.687-026	729.281-026	729.381-010
TASK NO.	UNIT COMPETENCIES	DATE	IN'T.																
	DESIGNING AND MODIFYING SYSTEMS																		
DMS-01	Designing voltage amplifiers			X	X		X	X											
DMS-02	Designing wave shaping circuits			X	X		X	X											
DMS-03	Designing logic circuits			X	X		X	X											
DMS-04	Modifying schematics			X	X		*X	X											
DMS-05	Laying out, taping up and drawing basic printed circuit boards			X	X			X											
DMS-06	Constructing printed circuit (PC) boards			X	X			X											
DMS-07	Modifying circuits to accommodate integrated circuits (IC)			X	X			X											
DMS-08	Preparing assembly guides			X	X			X											
DMS-09	Preparing parts lists			X	X			X											
DMS-10	Making truth tables for logic gates			*X	*X			*X											

This is to certify that the above named student has demonstrated proficiency in the performance of the competencies and/or tasks indicated above. These competencies and/or tasks have been determined to be the skills and knowledge that are necessary for entry level employment into the job classifications indicated.

Date__________ Instructor____________________

School____________________

Instructor____________________

Instructor____________________

Instructor____________________

Instructor____________________

*Certificate of Competency can be issued

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CERTIFICATE OF COMPETENCY

This is to Certify that

____

of

____

has successfully mastered the competencies required to perform the job of

INSTRUMENTATION TECHNICIAN

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The student named on this certificate has demonstrated mastery of the following unit level competencies required to perform the job of Instrumentation Technician.

INSTRUMENTATION TECHNICIAN
(D.O.T. Code 003.261-010)

Safety Procedures and Tools
Identifying plant safety procedures
Observing safety precautions for tools and equipment
Identifying machinery safeguards
Observing safety in handling materials
Identifying work area safety precautions
Identifying fire prevention procedures
Handling hazardous materials
Observing electrical safety precautions
Identifying personal protection gear
Identifying and using hand tools
Identifying and using power tools
Identifying types of fasteners
Identifying and using wrenches and screwdrivers
Identifying and using pipefitting tools
Identifying and using plumbing tools
Identifying and using electrical tools
Identifying and using sheet metal tools
Identifying and using metalworking tools
Identifying and using hoisting and pulling tools

Blueprints, Schematics and Diagrams
Identifying basic principles of blueprint reading
Identifying elements of machine drawings
Identifying hydraulic and pneumatic drawings
Reading building drawings
Reading electrical drawings
Reading pipe system drawings
Reading sheet metal drawings
Using shop math to interpret blueprints
Sketching schematic diagrams
Identifying types of schematics used in plant engineering
Identifying the symbols on electrical piping and fluid power diagrams
Identifying guidelines for reading schematics
Identifying electrical symbols
Reading electrical diagrams
Identifying piping symbols
Reading piping schematics
Identifying fluid power symbols
Reading fluid power schematics
Identifying welding symbols
Drawing electrical one-line diagrams from engineering sketches
Drawing electrical elementary diagrams from engineering sketches
Drawing electronic schematic diagrams from engineering sketches

Identifying pressure control valves
Identifying cylinders in a hydraulic system
Identifying hydraulic motors
Troubleshooting hydraulic systems schematics
Reading hydraulic schematic diagrams
Installing hydraulic components
Installing pipes and tubes
Selecting hydraulic fluids
Planning system maintenance
Troubleshooting hydraulic systems (diagnostic technique)
Troubleshooting valves
Troubleshooting cylinders
Troubleshooting pumps and motors
Identifying basic packaging methods
Identifying actuating mechanisms
Identifying basic troubleshooting principles of packaging machinery
Identifying mechanical drives
Identifying motors and brakes
Identifying electrical controls
Identifying packaging materials
Identifying methods of filling containers
Identifying methods of sealing
Identifying the processes used for heat treatment of material
Identifying the processes used to produce plastics
Identifying the processes used to produce iron
Identifying processes used to produce steel
Identifying processes used to produce aluminum
Identifying processes for the production of magnesium and titanium
Identifying processes used to produce copper
Identifying processes used to produce lead, nickel, tin and zinc
Identifying common couplings
Identifying clutches

Identification of Test Instruments
Identifying and using basic measuring instruments
Identifying and using volt-ohm milliammeters (VOM)
Identifying and using electrical voltmeters (EVM)
Identifying and using ohmmeters
Identifying and using oscilloscopes
Identifying and using tube testers
Identifying and using transistor analysers
Identifying and using capacitor testers
Identifying and using sine wave generators
Identifying and using signal generators
Identifying and using pulse generators
Identifying and using square wave generators

Understanding the fundamentals of field effect transistors and their electrical characteristics
Understanding the fundamentals of thyristors and their electrical characteristics
Understanding fundamentals of integrated circuits
Defining the operating values and applications of opto-electronic devices
Identifying the component parts and operational characteristics of diode vacuum tubes
Identifying the component parts and operating characteristics of triode vacuum tubes
Identifying the component parts and operating characteristics of tetrode vacuum tubes
Identifying the component parts and operating characteristics of pentode vacuum tubes
Performing condition testing of the thermal stability and operational parameters of a common-emitter amplifier circuit
Performing condition testing of DC and audio amplifiers
Defining electrical characteristics, applications and normal operational values of amplifiers

Electrical Equipment Servicing
Performing a visual inspection of electronic equipment
Cleaning electronic equipment
Lubricating electronic equipment
Inspecting and replacing power cords and distribution cables
Inspecting and replacing vacuum tubes
Inspecting and replacing transistors
Inspecting and replacing IC units
Inspecting and replacing printed circuit (PC) boards
Performing a proof of performance on electronic equipment
Keeping records on maintenance of equipment

DC Techniques
Determining meter movement, sensitivity and resistance
Extending the current range of a meter movement
Extending the voltage range of a meter movement
Performing a condition test of a semi-conductor diode using an ohmmeter

Low Frequency Techniques
Testing an amplifier for amplification
Testing and repairing the vacuum tube amplifier

Preparing preliminary sketches
Drawing logic symbols

Properties of Materials

Identifying the physical structure of metals
Identifying properties of metals
Identifying non-metal materials
Identifying properties and applications of carbon
Identifying properties of rubber
Identifying properties of industrial chemicals
Identifying the properties of paints, coatings and their applications
Identifying the properties of insulating materials and their applications
Identifying properties and applications of construction materials
Identifying properties and applications of wood
Identifying adhesives and tapes
Identifying basic principles of lubrication
Identifying oils and their applications
Identifying general purpose greases
Identifying lubricating compounds
Identifying hydraulic fluids

Manufacturing Processes

Identifying practical applications of power
Identifying pneumatic principles
Identifying reciprocating compressors
Identifying rotary compressors
Identifying primary air treatment in pneumatic systems
Identifying secondary air treatment methods
Identifying piping, hoses and fittings used in pneumatic systems
Identifying control valves
Identifying pressure relief valves
Identifying cylinders
Identifying motors
Identifying components of pneumatic systems
Reading pneumatic schematic diagrams
Installing system components
Identifying procedures for pneumatic system maintenance
Determining system failures
Troubleshooting air compressors
Troubleshooting control valves
Troubleshooting cylinders
Troubleshooting air motors
Troubleshooting a pneumatic and hydraulic system
Identifying metal manufacturing processes
Identifying strainers and filters in hydraulic systems
Identifying reservoirs and accumulators in a hydraulic system
Identifying hydraulic pumps on a system
Identifying piping, tubing and fittings
Identifying directional control valves
Identifying and using impedance testers
Identifying and using frequency meters
Using test instruments to measure voltage, current and resistance
Calculating values in DC network circuits
Calculating and measuring electrical values in AC capacitance circuits
Measuring inductance in series RL circuits
Calculating capacitance and time constants for RC circuits
Measuring AC values for LF circuits

Physical Properties Measurements

Identifying the nature of force
Identifying physical properties of motion
Identifying principles of work and energy
Identifying principles of simple machines
Calculating area and volume
Identifying properties of friction

DC Measurement Principles

Understanding fundamentals of electrical theory and electrical measurement
Making calculations using Ohm's law
Measuring current in DC circuits
Measuring voltage in DC circuits
Calculating and measuring resistance in DC circuits
Calculating voltage, current and resistance in DC series circuits
Calculating total voltage, total current and total resistance in DC parallel circuits
Calculating and measuring electrical quantities in combination DC circuits
Calculating power in DC circuits
Applying fundamentals of magnetism and electromagnetism

Low Frequency Measurements

Calculating values for a right triangle
Identifying the characteristics of AC sine waves
Computing turns, voltage, current and impedance ratios of transformers
Determining reactance and impedance of a capacitor in either series or parallel circuits
Drawing phasor diagrams and calculating operating values for series AC circuits
Drawing phasor diagrams and calculating operating values for parallel AC circuits

High Frequency Measurement Principles

Understanding fundamentals of tuned AC circuits
Understanding fundamentals of semi-conductor materials
Identifying symbols and electrical characteristics of tunnel, varactor and high frequency diodes
Understanding the fundamentals of bipolar transistors and their electrical characteristics
Performing condition tests of bipolar transistors
Testing and repairing a transistor amplifier
Identifying component parts and electrical characteristics of power supply circuits
Testing and repairing power supplies

High Frequency Techniques

Testing and repairing oscillators
Testing and repairing clampers
Testing and repairing clipper circuits
Testing and repairing counters
Constructing oscillators and performing a condition test of the oscillators
Constructing and performing condition tests of pulse circuits
Testing and repairing non-sinusoidal amplifiers
Troubleshooting sweep-generator circuits
Troubleshooting electronic circuits
Performing a condition test of zener diodes used in regulator circuits

Calibration of Test Instruments

Performing condition test and calibration of volt-ohm milliameter (VOM)
Performing condition test and calibration of electrical voltmeters (EVM)
Performing condition test and calibration of tube testers
Performing condition test and calibration of a transistor tester
Performing condition test and calibration of resistor substitution box
Performing condition test and calibration of oscilloscopes
Performing condition test and calibration of sine wave generators
Performing condition test and calibration of square wave and pulse generators
Performing condition test and calibration of frequency meters
Calibrating power supply voltage

Servicing Instrumentation Systems

Identifying automatic control system functions
Identifying the elements of process control
Identifying system transmitters and receivers process loops
Identifying diagram symbols and networks
Identifying parameters of an operational process control system
Identifying measurement purpose and requirements
Identifying the elements of measurement systems
Identifying measurement transducers
Identifying instrument calibration standards units
Analyzing systems using troubleshooting flow sheet
Identifying pressure principles
Identifying pressure sensors
Identifying pressure transducers

Service Instrumentation Systems (Continued)

Identifying low pressure measurement gage requirements
Installing and servicing pressure instruments
Identifying force, stress and strain measurement units
Identifying weight and mass measuring instruments
Identifying methods for weighing materials in motion
Identifying displacement measurement methods
Identifying acceleration, vibration and shock measurement methods
Identifying the properties of fluid flow measurement
Identifying primary measuring devices for fluid flow
Identifying secondary measuring devices for fluid flow
Identifying applications for variable area instruments
Identifying open channel flow devices
Identifying applications for positive displacement meters
Identifying applications for turbine and magnetic flow meters
Identifying types of fluid flow meters
Identifying solid particles flow metering methods
Installing and maintaining flow instruments
Identifying level measurement instruments
Identifying pressure head instruments
Identifying electrical methods for level measurement
Identifying solid level measuring systems
Servicing level measuring instruments
Identifying temperature measurement principles
Identifying bimetallic and fluid filled temperature measuring instruments
Identifying instruments using electrical methods of measuring temperature
Identifying pyrometers
Performing temperature measuring instrument maintenance and calibration
Identifying final control elements in process loops
Identifying electric activators
Identifying pneumatic and hydraulic activators
Identifying control valves
Identifying control element applications
Identifying on-site safety standards and maintenance practices
Identifying servicing requirements
Detailing electrical and electronic stations
Detailing pneumatic and hydraulic stations
Detailing troubleshooting requirements

Designing and Modifying Systems

Designing voltage amplifiers
Designing wave shape circuits
Designing logic circuits
Modifying schematics
Laying out, taping up and drawing basic printed circuit boards
Constructing printed circuit (PC) boards
Modifying circuits to accommodate integrated circuits (IC)
Preparing assembly guides
Preparing parts lists
Making truth tables for logic gates

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CERTIFICATE OF COMPETENCY

This is to Certify that

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of

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has successfully mastered the competencies required to perform the job of

ELECTRICAL EQUIPMENT TESTER

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The student named on this certificate has demonstrated mastery of the following unit level competencies required to perform the job of Electrical Equipment Tester.

ELECTRICAL EQUIPMENT TESTER
(D.O.T. Code 729.381-010)

Safety Procedures and Tools
- Identifying plant safety procedures
- Observing safety precautions for tools and equipment
- Identifying machinery safeguards
- Observing safety in handling materials
- Identifying work area safety precautions
- Identifying fire prevention procedures
- Handling hazardous materials
- Observing electrical safety precautions
- Identifying personal protection gear
- Identifying and using hand tools
- Identifying and using power tools
- Identifying types of fasteners
- Identifying and using wrenches and screwdrivers
- Identifying and using pipefitting tools
- Identifying and using plumbing tools
- Identifying and using electrical tools
- Identifying and using sheet metal tools
- Identifying and using metalworking tools
- Identifying and using hoisting and pulling tools

Blueprints, Schematics and Diagrams
- Identifying basic principles of blueprint reading
- Identifying elements of machine drawings
- Reading electrical drawings
- Using shop math to interpret blueprints
- Identifying types of schematics used in plant engineering
- Identifying guidelines for reading schematics
- Reading electrical diagrams

Properties of Materials
- Identifying the physical structure of metals
- Identifying properties of metals
- Identifying non-metal materials
- Identifying properties and applications of carbon
- Identifying properties of rubber
- Identifying properties of industrial chemicals
- Identifying the properties of paints, coatings and their applications
- Identifying the properties of insulation materials and their applications
- Identifying properties and applications of construction materials
- Identifying properties and applications of wood
- Identifying adhesives and tapes
- Identifying basic principles of lubrication
- Identifying oils and their applications
- Identifying general purpose greases
- Identifying lubricating compounds
- Identifying hydraulic fluids

Identification of Test Instruments
- Identifying and using basic measuring instruments
- Identifying and using volt-ohm milliammeters (VOM)
- Identifying and using electrical voltmeters (EVM)
- Identifying and using ohmmeters
- Identifying and using oscilloscopes
- Identifying and using tube testers
- Identifying and using transistor analyzers
- Identifying and using capacitor testers
- Identifying and using sine wave generators
- Identifying and using signal generators
- Identifying and using pulse generators
- Identifying and using sqaure wave generators
- Using test instruments to measure voltage, current and resistance
- Calculating values in DC network circuits
- Calculating and measuring electrical values in AC capacitance circuits
- Measuring inductance in series RL circuits
- Calculating capacitance and time constants for RC circuits
- Measuring AC values for LF circuits

Physical Properties Measurements
- Identifying the nature of force
- Identifying physical properties of motion
- Identifying principles of work and energy
- Identifying principles of simple machines
- Calculating area and volume
- Identifying properties of friction

DC Measurement Principles
- Understanding fundamentals of electrical theory and electrical measurement
- Making calculations using Ohm's law
- Measuring current in DC circuits
- Measuring voltage in DC circuits
- Calculating and measuring resistance in DC circuits
- Calculating voltage, current and resistance in DC series circuits
- Calculating total voltage, total current and total resistance in DC parallel circuits
- Calculating and measuring electrical quantities in combination DC circuits
- Calculating power in DC circuits
- Applying fundamentals of magnetism and electromagnetism

Low Frequency Measurements
- Calculating values for a right triangle
- Identifying the characteristics of AC sine waves
- Computing turns, voltage, current and impedance ratios of transformers
- Determining reactance and impedance of a capacitor in either series or parallel circuits
- Drawing phasor diagrams and calculating operating values for series AC circuits
- Drawing phasor diagrams and calculating operating values for parallel AC circuits

Electrical Equipment Servicing
- Performing a visual inspection of electronic equipment
- Cleaning electronic equipment
- Lubricating electronic equipment
- Inspecting and replacing power cords and distribution cables
- Inspecting and replacing vacuum tubes
- Inspecting and replacing transistors
- Inspecting and replacing IC units
- Inspecting and replacing printed circuit (PC) boards
- Performing a proof of performance on electronic equipment
- Keeping records on maintenance of equipment

DC Techniques
- Determining meter movement, sensitivity and resistance
- Extending the current range of a meter movement
- Extending the voltage range of a meter movement
- Performing a condition test of a semi-conductor diode using an ohmmeter

Low Frequency Techniques
- Testing an amplifier for amplification
- Testing and repairing the vacuum tube amplifier
- Testing and repairing a transistor amplifier
- Identifying component parts and electrical characteristics of power supply circuits
- Testing and repairing power supplies

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CERTIFICATE OF COMPETENCY

This is to Certify that

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of

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has successfully mastered the competencies required to perform the job of

INSTRUMENT MECHANIC

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The student named on this certificate has demonstrated mastery of the following unit level competencies required to perform the job of Instrument Mechanic.

INSTRUMENT MECHANIC
(D.O.T. Code 710.281-026)

Safety Procedures and Tools
Identifying plant safety procedures
Observing safety precautions for tools and equipment
Identifying machinery safeguards
Observing safety in handling materials
Identifying work area safety precautions
Identifying fire prevention procedures
Handling hazardous materials
Observing electrical safety precautions
Identifying personal protection gear
Identifying and using hand tools
Identifying and using power tools
Identifying types of fasteners
Identifying and using wrenches and screwdrivers
Identifying and using pipefitting tools
Identifying and using plumbing tools
Identifying and using electrical tools
Identifying and using sheet metal tools
Identifying and using metalworking tools
Identifying and using hoisting and pulling tools

Blueprints, Schematics and Diagrams
Identifying basic principles of blueprint reading
Identifying elements of machine drawings
Identifying the symbols on electrical piping and fluid power diagrams
Identifying guidelines for reading schematics
Identifying electrical symbols
Reading electrical diagrams
Identifying piping symbols
Reading piping schematics
Identifying fluid power symbols
Reading fluid power schematics
Identifying welding symbols
Drawing electrical one-line diagrams from engineering sketches
Drawing electrical elementary diagrams from engineering sketches
Drawing electronic schematic diagrams from engineering sketches
Preparing preliminary sketches
Drawing logic symbols

Properties of Materials
Identifying the physical structure of metals
Identifying properties of metals
Identifying non-metal materials
Identifying properties and applications of carbon
Identifying properties of rubber
Identifying properties of industrial chemicals

Making calculations using Ohm's law
Measuring current in DC circuits
Measuring voltage in DC circuits
Calculating and measuring resistance in DC circuits
Calculating voltage, current and resistance in DC series circuits
Calculating total voltage, total current and total resistance in DC parallel circuits
Calculating and measuring electrical quantities in combination DC circuits
Calculating power in DC circuits
Applying fundamentals of magnetism and electromagnetism

Low Frequency Measurements
Calculating values for a right triangle
Identifying the characteristics of AC sine waves
Computing turns, voltage, current and impedance ratios of transformers
Determining reactance and impedance of a capacitor in either series or parallel circuits
Drawing phasor diagrams and calculating operating values for series AC circuits
Drawing phasor diagrams and calculating operating values for parallel AC circuits

High Frequency Measurement Principles
Understanding fundamentals of tuned AC circuits
Understanding fundamentals of semi-conductor materials
Identifying symbols and electrical characteristics of tunnel, varactor and high frequency diodes
Understanding the fundamentals of bipolar transistors and their electrical characteristics
Performing condition tests of bipolar transistors
Understanding the fundamentals of field effect transistors and their electrical characteristics
Understanding the fundamentals of thristors and their electrical characteristics
Understanding fundamentals of integrated circuits
Defining the operating values and applications of opto-electronic devices
Identifying the component parts and operational characteristics of diode vacuum tubes
Identifying the component parts and operating characteristics of triode vacuum tubes
Identifying the component parts and operating characteristics of tetrode vacuum tubes
Identifying the component parts and operating characteristics of pentode vacuum tubes

Troubleshooting sweep-generator circuits
Troubleshooting electronic circuits
Performing a condition test of zener diodes used in regulator circuits

Calibration of Test Instruments
Performing condition test and calibration of volt-ohm milliammeter (VOM)
Performing condition test and calibration of electrical voltmeters (EVM)
Performing condition test and calibration of tube testers
Performing condition test and calibration of a transistor tester
Performing condition test and calibration of resistor substitution box
Performing condition test and calibration of oscilloscopes
Performing condition test and calibration of sine wave generators
Performing condition test and calibration of square wave and pulse generators
Performing condition test and calibration of frequency meters
Calibrating power supply voltage

Servicing Instrumentation Systems
Identifying automatic control system functions
Identifying the elements of process control
Identifying system transmitters and receivers process loops
Identifying diagram symbols and networks
Identifying parameters of an operational process control system
Identifying measurement purpose and requirements
Identifying the elements of measurement systems
Identifying measurement transducers
Identifying instrument calibration standards units
Analyzing systems using troubleshooting flow sheet
Identifying pressure principles
Identifying pressure sensors
Identifying pressure transducers
Identifying low pressure measurement gage requirements
Installing and servicing pressure instruments
Identifying force, stress and strain measurement units
Identifying weight and mass measuring instruments
Identifying methods for weighing materials in motion
Identifying displacement measurement methods

Identifying the properties of paints, coatings and their applications
Identifying the properties of insulating materials and their applications
Identifying properties and applications of construction materials
Identifying properties and applications of wood
Identifying adhesives and tapes
Identifying basic principles of lubrication
Identifying oils and their applications
Identifying general purpose greases
Identifying lubricating compounds
Identifying hydraulic fluids

Identification of Test Instruments

Identifying and using basic measuring instruments
Identifying and using volt-ohm milliammeters (VOM)
Identifying and using electrical voltmeters (EVM)
Identifying and using ohmmeters
Identifying and using oscilloscopes
Identifying and using tube testers
Identifying and using transistor analyzers
Identifying and using capacitor testers
Identifying and using sine wave generators
Identifying and using signal generators
Identifying and using pulse generators
Identifying and using square wave generators
Identifying and using impedance testers
Identifying and using frequency meters
Using test instruments to measure voltage, current and resistance
Calculating values in DC network circuits
Calculating and measuring electrical values in AC capacitance circuits
Measuring inductance in series RL circuits
Calculating capacitance and time constants for RC circuits
Measuring AC values for LF circuits

Physical Properties Measurements

Identifying the nature of force
Identifying physical properties of motion
Identifying principles of work and energy
Identifying principles of simple machines
Calculating area and volume
Identifying properties of friction

DC Measurement Principles

Understanding fundamentals of electrical theory and electrical measurement

Performing condition testing of the thermal stability and operational parameters of a common-emitter amplifier circuit
Performing condition testing of DC and audio amplifiers
Defining electrical characteristics, applications and normal operational values of amplifiers

Electrical Equipment Servicing

Performing a visual inspection of electronic equipment
Cleaning electronic equipment
Lubricating electronic equipment
Inspecting and replacing power cords and distribution cables
Inspecting and replacing vacuum tubes
Inspecting and replacing transistors
Inspecting and replacing IC units
Inspecting and replacing printed circuit (PC) boards
Performing a proof of performance on electronic equipment
Keeping records on maintenance of equipment

DC Techniques

Determining meter movement, sensitivity and resistance
Extending the current range of a meter movement
Extending the voltage range of a meter movement
Performing a condition test of a semi-conductor diode using an ohmmeter

Low Frequency Techniques

Testing an amplifier for amplification
Testing and repairing the vacuum tube amplifier
Testing and repairing a transistor amplifier
Identifying component parts and electrical characteristics of power supply circuits
Testing and repairing power supplies

High Frequency Techniques

Testing and repairing oscillators
Testing and repairing clampers
Testing and repairing clipper circuits
Testing and repairing counters
Constructing oscillators and performing a condition test of the oscillators
Constructing and performing condition tests of pulse circuits
Testing and repairing non-sinusoidal amplifiers

Identifying acceleration, vibration and shock measurement methods
Identifying the properties of fluid flow measurement
Identifying primary measuring devices for fluid flow
Identifying secondary measuring devices for fluid flow
Identifying applications for variable area instruments
Identifying open channel flow devices
Identifying applications for positive displacement meters
Identifying applications for turbine and magnetic flow meters
Identifying types of fluid flow meters
Identifying solid particles flow metering methods
Installing and maintaining flow instruments
Identifying level measurement instruments
Identifying pressure head instruments
Identifying electrical methods for level measurement
Identifying solid level measuring systems
Servicing level measuring instruments
Identifying temperature measurement principles
Identifying bimetallic and fluid filled temperature measuring instruments
Identifying instruments using electrical methods of measuring temperature
Identifying pyrometers
Performing temperature measuring instrument maintenance and calibration
Identifying final control elements in process loops
Identifying electric activators
Identifying pneumatic and hydraulic activators
Identifying control valves
Identifying control element applications
Identifying on-site safety standards and maintenance practices
Identifying servicing requirements
Detailing electrical and electronic stations
Detailing pneumatic and hydraulic stations
Detailing troubleshooting requirements

Designing and Modifying Systems

Designing voltage amplifiers
Designing wave shape circuits
Designing logic circuits
Modifying schematics

CERTIFICATE OF COMPETENCY

This is to Certify that

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of

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has successfully mastered the competencies required to perform the job of

INSPECTOR
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The student named on this certificate has demonstrated mastery of the following unit level competencies required to perform the job of Inspector.

INSPECTOR
(D.O.T. Code 710.381-034)

Safety Procedures and Tools
- Identifying plant safety procedures
- Observing safety precautions for tools and equipment
- Identifying machinery safeguards
- Observing safety in handling materials
- Identifying work area safety precautions
- Identifying fire prevention procedures
- Handling hazardous materials
- Observing electrical safety precautions
- Identifying personal protection gear
- Identifying and using hand tools
- Identifying and using power tools
- Identifying types of fasteners
- Identifying and using wrenches and screwdrivers
- Identifying and using pipefitting tools
- Identifying and using plumbing tools
- Identifying and using electrical tools
- Identifying and using sheet metal tools
- Identifying and using hoisting and pulling tools

Blueprints, Schematics and Diagrams
- Identifying basic principles of blueprint reading
- Identifying elements of machine drawings
- Identifying the symbols on electrical piping and fluid power diagrams
- Identifying guidelines for reading schematics
- Identifying electrical symbols
- Reading electrical diagrams
- Identifying piping symbols
- Reading piping schematics
- Identifying fluid power symbols
- Reading fluid power schematics
- Identifying welding symbols
- Drawing electrical one-line diagrams from engineering sketches
- Drawing electrical elementary diagrams from engineering sketches
- Drawing electronic schematic diagrams from engineering sketches
- Preparing preliminary sketches
- Drawing logic symbols

Properties of Materials
- Identifying the physical structure of metals
- Identifying properties of metals
- Identifying non-metal materials
- Identifying properties and applications of carbon
- Identifying properties of rubber
- Identifying properties of industrial chemicals
- Identifying the properties of paints, coatings and their applications
- Identifying the properties of insulating materials and their applications
- Identifying properties and applications of construction materials
- Identifying properties and applications of wood
- Identifying adhesives and tapes
- Identifying basic principles of lubrication
- Identifying oils and their applications
- Identifying general purpose greases
- Identifying lubricating compounds
- Identifying hydraulic fluids

Identification of Test Instruments
- Identifying and using basic measuring instruments
- Identifying and using volt-ohm milliammeters (VOM)
- Identifying and using ohmmeters

Physical Properties Measurements
- Identifying the nature of force
- Identifying physical properties of motion
- Identifying principles of work and energy
- Identifying principles of simple machines
- Calculating area and volume
- Identifying properties of friction

DC Measurement Principles
- Understanding fundamentals of electrical theory and electrical measurement
- Making calculations using Ohm's law
- Measuring current in DC circuits
- Measuring voltage in DC circuits
- Calculating and measuring resistance in DC circuits
- Calculating voltage, current and resistance in DC series circuits
- Calculating total voltage, total current and total resistance in DC parallel circuits
- Calculating and measuring electrical quantities in combination DC circuits
- Calculating power in DC circuits
- Applying fundamentals of magnetism and electromagnetism

Low Frequency Measurements
- Calculating values for a right triangle
- Identifying the characteristics of AC sine waves
- Computing turns, voltage, current and impedance ratios of transformers
- Determining reactance and impedance of a capacitor in either series or parallel circuits
- Drawing phasor diagrams and calculating operating values for series AC circuits
- Drawing phasor diagrams and calculating operating values for parallel AC circuits

Electrical Equipment Servicing
- Performing a visual inspection of electronic equipment
- Cleaning electronic equipment
- Lubricating electronic equipment
- Inspecting and replacing power cords and distribution cables
- Inspecting and replacing vacuum tubes
- Inspecting and replacing transistors
- Inspecting and replacing IC units
- Inspecting and replacing printed circuit (PC) boards
- Performing a proof of performance on electronic equipment
- Keeping records on maintenance of equipment

DC Techniques
- Determining meter movement, sensitivity and resistance
- Extending the current range of a meter movement
- Extending the voltage range of a meter movement
- Performing a condition test of a semi-conductor diode using an ohmmeter

Low Frequency Techniques
- Testing an amplifier for amplification
- Testing and repairing the vacuum tube amplifier
- Testing and repairing a transistor amplifier
- Identifying component parts and electrical characteristics of power supply circuits
- Testing and repairing power supplies

Designing and Modifying Systems
- Designing voltage amplifiers
- Designing wave shape circuits
- Designing logic circuits
- Modifying schematics
- Laying out, taping up and drawing basic printed circuit boards
- Constructing printed circuit (PC) boards
- Modifying circuits to accommodate integrated circuits (IC)
- Preparing assembly guides
- Preparing parts lists
- Making truth tables for logic gates

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CERTIFICATE OF COMPETENCY

This is to Certify that

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of

____

has successfully mastered the competencies required to perform the job of

INSPECTOR, MECHANICAL AND ELECTRICAL

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The student named on this certificate has demonstrated mastery of the following unit level competencies required to perform the job of Inspector, Mechanical and Electrical.

INSPECTOR, MECHANICAL AND ELECTRICAL
(D.O.T. Code 710.381-038)

Safety Procedures and Tools
Identifying plant safety procedures
Observing safety precautions for tools and equipment
Identifying machinery safeguards
Observing safety in handling materials
Identifying work area safety precautions
Identifying fire prevention procedures
Handling hazardous materials
Observing electrical safety precautions
Identify personal protection gear
Identifying and using hand tools
Identifying and using power tools
Identifying types of fasteners
Identifying and using wrenches and screwdrivers
Identifying and using pipefitting tools
Identifying and using plumbing tools
Identifying and using electrical tools
Identifying and using sheet metal tools
Identifying and using metalworking tools
Identifying and using hoisting and pulling tools

Blueprints, Schematics and Diagrams
Identifying basic principles of blueprint reading
Identifying elements of machine drawings
Identifying hydraulic and pneumatic drawings
Reading building drawings
Reading electrical drawings
Reading pipe system drawings
Reading sheet metal drawings
Using shop math to interpret blueprints
Sketching schematic diagrams
Identifying types of schematics used in plant engineering
Identifying the symbols on electrical piping and fluid power diagrams
Identifying guidelines for reading schematics
Identifying electrical symbols
Reading electrical diagrams
Identifying piping symbols
Reading piping schematics
Identifying fluid power symbols
Reading fluid power schematics
Identifying welding symbols
Drawing electrical one-line diagrams from engineering sketches
Drawing electrical elementary diagrams from engineering sketches
Drawing electronic schematic diagrams from engineering sketches
Preparing preliminary sketches
Drawing logic symbols

Properties of Materials
Identifying the physical structure of metals
Identifying properties of metals
Identifying non-metal materials
Identifying properties and applications of carbon
Identifying properties of rubber
Identifying properties of industrial chemicals
Identifying the properties of paints, coatings and their applications
Identifying the properties of insulating materials and their applications
Identifying properties and applications of construction materials
Identifying properties and applications of wood
Identifying adhesives and tapes
Identifying basic principles of lubrication
Identifying oils and their applications
Identifying general purpose greases
Identifying lubricating compounds
Identifying hydraulic fluids

Identification of Test Instruments
Identifying and using basic measuring instruments
Identifying and using volt-ohm milliammeters (VOM)
Identifying and using ohmmeters
Identifying and using oscilloscopes

Physical Properties Measurements
Identifying the nature of force
Identifying physical properties of motion
Identifying principles of work and energy
Identifying principles of simple machines
Calculating area and volume
Identifying properties of friction

DC Measurement Principles
Understanding fundamentals of electrical theory and electrical measurement
Making calculations using Ohm's law
Measuring current in DC circuits
Measuring voltage in DC circuits
Calculating and measuring resistance in DC circuits
Calculating voltage, current and resistance in DC series circuits
Calculating total voltage, total current and total resistance in DC parallel circuits
Calculating and measuring electrical quantities in combination DC circuits
Calculating power in DC circuits
Applying fundamentals of magnetism and electromagnetism

Low Frequency Measurements
Calculating values for a right triangle
Identifying the characteristics of AC sine waves
Computing turns, voltage, current and impedance ratios of transformers
Determining reactance and impedance of a capacitor in either series or parallel circuits
Drawing phasor diagrams and calculating operating values for series AC circuits
Drawing phasor diagrams and calculating operating values for parallel AC circuits

DC Techniques
Determining meter movement, sensitivity and resistance
Extending the current range of a meter movement
Extending the voltage range of a meter movement
Performing a condition test of a semi-conductor diode using an ohmmeter

Low Frequency Techniques
Testing an amplifier for amplification
Testing and repairing the vacuum tube amplifier
Testing and repairing a transistor amplifier
Identifying component parts and electrical characteristics of power supply circuits
Testing and repairing power supplies

CERTIFICATE OF COMPETENCY

This is to Certify that

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of

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has successfully mastered the competencies required to perform the job of

INSTRUMENT TECHNICIAN
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The student named on this certificate has demonstrated mastery of the following unit level competencies required to perform the job of Instrument Technician.

INSTRUMENT TECHNICIAN
(D.O.T. Code 710.281-030)

Safety Procedures and Tools
- Identifying plant safety procedures
- Observing safety precautions for tools and equipment
- Identifying machinery safeguards
- Observing safety in handling materials
- Identifying work area safety precautions
- Identifying fire prevention procedures
- Handling hazardous materials
- Observing electrical safety precautions
- Identifying personal protection gear
- Identifying and using hand tools
- Identifying and using power tools
- Identifying types of fasteners
- Identifying and using wrenches and screwdrivers
- Identifying and using pipefitting tools
- Identifying and using plumbing tools
- Identifying and using electrical tools
- Identifying and using sheet metal tools
- Identifying and using metalworking tools
- Identifying and using hoisting and pulling tools

Blueprint, Schematics and Diagrams
- Identifying basic principles of blueprint reading
- Identifying elements of machine drawings
- Identifying the symbols on electrical piping and fluid power diagrams
- Identifying guidelines for reading schematics
- Identifying electrical symbols
- Reading electrical diagrams
- Identifying piping symbols
- Reading piping schematics
- Identifying fluid power symbols
- Reading fluid power schematics
- Identifying welding symbols
- Drawing electrical one-line diagrams from engineering sketches
- Drawing electrical elementary diagrams from engineering sketches
- Drawing electronic schematic diagrams from engineering sketches
- Preparing preliminary sketches
- Drawing logic symbols

Properties of Materials
- Identifying the physical structure of metals
- Identifying properties of metals
- Identifying non-metal materials
- Identifying properties and applications of carbon
- Identifying properties of rubber
- Identifying properties of industrial chemicals

DC Measurement Principles
- Understanding fundamentals of electrical theory and electrical measurement
- Making calculations using Ohm's law
- Measuring current in DC circuits
- Measuring voltage in DC circuits
- Calculating and measuring resistance in DC circuits
- Calculating voltage, current and resistance in DC series circuits
- Calculating total voltage, total current and total resistance in DC parallel circuits
- Calculating and measuring electrical quantities in combination DC circuits
- Calculating power in DC circuits
- Applying fundamentals of magnetism and electromagnetism

Low Frequency Measurements
- Calculating values for a right triangle
- Identifying the characteristics of AC sine waves
- Computing turns, voltage, current and impedance ratios of transformers
- Determining reactance and impedance of a capacitor in either series or parallel circuits
- Drawing phasor diagrams and calculating operating values for series AC circuits
- Drawing phasor diagrams and calculating operating values for parallel AC circuits

High Frequency Measurement Principles
- Understanding fundamentals of tuned AC circuits
- Understanding fundamentals of semi-conductor materials
- Identifying symbols and electrical characteristics of tunnel, varactor and high frequency diodes
- Understanding the fundamentals of bipolar transistors and their electrical characteristics
- Performing condition tests of bipolar transistors
- Understanding the fundamentals of field effect transistors and their electrical characteristics
- Understanding the fundamentals of thyristors and their electrical characteristics
- Understanding fundamentals of integrated circuits
- Defining the operating values and applications of opto-electronic devices
- Identifying the component parts and operations characteristics of diode vacuum tubes
- Identifying the component parts and operating characteristics of triode vacuum tubes
- Identifying the component parts and operating characteristics of tetrode vacuum tubes
- Constructing and performing condition tests of pulse circuits
- Testing and repairing non-sinusoidal amplifiers
- Troubleshooting sweep-generator circuits
- Troubleshooting electronic circuits
- Performing a condition test of zener diodes used in regulator circuits

Calibration of Test Instruments
- Performing condition test and calibration of volt-ohm milliammeter (VOM)
- Performing condition test and calibration of electrical voltmeters (EVM)
- Performing condition test and calibration of tube testers
- Performing condition test and calibration of a transistor tester
- Performing condition test and calibration of resistor substitution box
- Performing condition test and calibration of oscilloscopes
- Performing condition test and calibration of sine wave generators
- Performing condition test and calibration of square wave generators
- Performing condition test and calibration of frequency meters
- Calibrating power supply voltage

Servicing Instrumentation Systems
- Identifying automatic control system functions
- Identifying the elements of process control
- Identifying system transmitters and receivers process loops
- Identifying diagram symbols and networks
- Identifying parameters of an operational process control system
- Identifying measurement purpose and requirements
- Identifying the elements of measurement systems
- Identifying measurement transducers
- Identifying instrument calibration standards units
- Analyzing systems using troubleshooting flow sheet
- Identifying pressure principles
- Identifying pressure sensors
- Identifying pressure transducers
- Identifying low pressure measurement gage requirements
- Installing and servicing pressure instruments
- Identifying force, stress and strain measurement units
- Identifying weight and mass measuring instruments

Identifying the properties of paints, coatings and their applications
Identifying the properties of insulating materials and their applications
Identifying properties and applications of construction materials
Identifying properties and applications of wood
Identifying adhesives and tapes
Identifying basic principles of lubrication
Identifying oils and their applications
Identifying general purpose greases
Identifying lubricating compounds
Identifying hydraulic fluids

Identification of Test Instruments

Identifying and using basic measuring instruments
Identifying and using volt-ohm milliammeters (VOM)
Identifying and using electrical voltmeters (EVM)
Identifying and using ohmmeters
Identifying and using oscilloscopes
Identifying and using tube testers
Identifying and using transistor analyzers
Identifying and using capacitor testers
Identifying and using sine wave generators
Identifying and using signal generators
Identifying and using pulse generators
Identifying and using square wave generators
Identifying and using impedance testers
Identifying and using frequency meters
Using test instruments to measure voltage, current and resistance
Calculating values in DC network circuits
Calculating and measuring electrical values in AC capacitance circuits
Measuring inductance in series RL circuits
Calculating capacitance and time constants for RC circuits
Measuring AC values for LF circuits

Physical Properties Measurements

Identifying the nature of force
Identifying physical properties of motion
Identifying principles of work and energy
Identifying principles of simple machines
Calculating area and volume
Identifying properties of friction

Identifying the component parts and operating characteristics of pentrode vacuum tubes
Performing condition testing of the thermal stability and operational parameters of a common-emitter amplifier circuit
Performing condition testing of DC and audio amplifiers
Defining electrical characteristics, applications and normal operational values of amplifiers

Electrical Equipment Servicing

Performing a visual inspection of electronic equipment
Cleaning electronic equipment
Lubricating electronic equipment
Inspecting and replacing power cords and distribution cables
Inspecting and replacing vacuum tubes
Inspecting and replacing transistors
Inspecting and replacing IC units
Inspecting and replacing printed circuit boards
Performing a proof of performance on electronic equipment
Keeping records on maintenance of equipment

DC Techniques

Determining meter movement, sensitivity and resistance
Extending the current range of a meter movement
Extending the voltage range of a meter movement
Performing a condition test of a semi-conductor diode using an ohmmeter

Low Frequency Techniques

Testing an amplifier for amplification
Testing and repairing the vacuum tube amplifier
Testing and repairing a transistor amplifier
Identifying component parts and electrical characteristics of power supply circuits
Testing and repairing power supplies

High Frequency Techniques

Testing and repairing oscillators
Testing and repairing clampers
Testing and repairing clipper circuits
Testing and repairing counters
Constructing oscillators and performing a condition test of the oscillators

Identifying methods for weighing materials in motion
Identifying displacement measurement methods
Identifying acceleration, vibration and shock measurement methods
Identifying the properties of fluid flow measurement
Identifying primary measuring devices for fluid flow
Identifying secondary measuring devices for fluid flow
Identifying applications for variable area instruments
Identifying open channel flow devices
Identifying applications for positive displacement meters
Identifying applications for turbine and magnetic flow meters
Identifying types of fluid flow meters
Identifying solid particles flow metering methods
Installing and maintaining flow instruments
Identifying level measurement instruments
Identifying pressure head instruments
Identifying electrical methods for level measurement
Identifying solid level measuring systems
Servicing level measuring instruments
Identifying temperature measurement principles
Identifying bimetallic and fluid filled temperature measuring instruments
Identifying instruments using electrical methods of measuring temperature
Identifying pyrometers
Performing temperature measuring instrument maintenance and calibration
Identifying final control elements in process loops
Identifying electric activators
Identifying pneumatic and hydraulic activators
Identifying control valves
Identifying control element applications
Identifying on-site safety standards and maintenance practices
Identifying servicing requirements
Detailing electrical and electronic stations
Detailing pneumatic and hydraulic stations
Detailing troubleshooting requirements

CERTIFICATE OF COMPETENCY

This is to Certify that

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of

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has successfully mastered the competencies required to perform the job of

TESTER, ELECTRONIC SCALE

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V-35

The student named on this certificate has demonstrated mastery of the following unit level competencies required to perform the job of Tester, Electronic Scale.

TESTER, ELECTRONIC SCALE
(D.O.T. Code 710.381-046)

Safety Procedures and Tools
Identifying plant safety procedures
Observing safety precautions for tools and equipment
Identifying machinery safeguards
Observing safety in handling materials
Identifying work area safety precautions
Identifying fire prevention procedures
Handling hazardous materials
Observing electrical safety precautions
Identifying personal protection gear
Identifying and using hand tools
Identifying and using power tools
Identifying types of fasteners
Identifying and using wrenches and screwdrivers
Identifying and using pipefitting tools
Identifying and using plumbing tools
Identifying and using electrical tools
Identifying and using sheet metal tools
Identifying and using metalworking tools
Identifying and using hoisting and pulling tools

Blueprints, Schematics and Diagrams
Identifying basic principles of blueprint reading
Using shop math to interpret blueprints
Identifying guidelines for reading schematics

Identification of Test Instruments
Identifying and using basic measuring instruments
Identifying and using volt-ohm milliammeters (VOM)
Identifying and using electrical voltmeters (EVM)
Identifying and using ohmmeters
Identifying and using oscilloscopes
Using test instruments to measure voltage, current and resistance
Calculating values in DC network circuits

Physical Properties Measurements
Identifying the nature of force
Identifying physical properties of motion
Identifying principles of work and energy
Identifying principles of simple machines
Calculating area and volume
Identifying properties of friction

DC Measurement Principles
Understanding fundamentals of electrical theory and electrical measurement
Making calculations using Ohm's law
Measuring current in DC circuits
Measuring voltage in DC circuits
Calculating and measuring resistance in DC circuits
Calculating voltage, current and resistance in DC series circuits
Calculating total voltage, total current and total resistance in DC parallel circuits
Calculating and measuring electrical quantities in combination DC circuits
Calculating power in DC circuits
Applying fundamentals of magnetism and electromagnetism

CERTIFICATE OF COMPETENCY

This is to Certify that

of

has successfully mastered the competencies required to perform the job of

INSTRUMENT CHECKER

The student named on this certificate has demonstrated mastery of the following unit level competencies required to perform the job of Instrument Checker.

INSTRUMENT CHECKER
(D.O.T. Code 710.687-026)

Safety Procedures and Tools
Identifying plant safety procedures
Observing safety precautions for tools and equipment
Identifying machinery safeguards
Observing safety in handling materials
Identifying work area safety precautions
Identifying fire prevention procedures
Handling hazardous materials
Observing electrical safety precautions
Identifying personal protection gear
Identifying and using hand tools
Identifying and using power tools
Identifying types of fasteners
Identifying and using wrenches and screwdrivers
Identifying and using pipefitting tools
Identifying and using plumbing tools
Identifying and using electrical tools
Identifying and using sheet metal tools
Identifying and using metalworking tools
Identifying and using hoisting and pulling tools

Blueprints, Schematics and Diagrams
Identifying basic principles of blueprint reading
Identifying elements of machine drawings
Reading electrical drawings
Using shop math to interpret blueprints
Identifying types of schematics used in plant engineering
Identifying guidelines for reading schematics
Reading electrical diagrams

Properties of Materials
Identifying the physical structure of metals
Identifying properties of metals
Identifying non-metal materials
Identifying properties and applications of carbon
Identifying properties of rubber
Identifying properites of industrial chemicals
Identifying the properties of paints, coatings and their applications
Identifying the properties of insulating materials and their applications
Identifying properties and applications of construction materials
Identifying properties and applications of wood
Identifying adhesives and tapes
Identifying basic principles of lubrication
Identifying oils and their applications
Identifying general purpose greases
Identifying lubricating compounds
Identifying hydraulic fluids

Identification of Test Instruments
Identifying and using basic measuring instruments
Identifying and using volt-ohm milliammeters (VOM)
Identifying and using electrical voltmeters (EVM)
Identifying and using ohmmeters
Identifying and using oscilloscopes
Identifying and using sine wave generators
Using test instruments to measure voltage, current and resistance
Calculating values in DC network circuits

DC Techniques
Determining meter movement, sensitivity and resistance
Extending the current range of a meter movement
Extending the voltage range of a meter movement
Performing a condition test of a semi-conductor diode using an ohmmeter

Low Frequency Techniques
Testing an amplifier for amplification
Testing and repairing the vacuum tube amplifier
Testing and repairing transistor amplifier
Identifying component parts and electrical characteristics of power supply circuits
Testing and repairing power supplies

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CERTIFICATE OF COMPETENCY

This is to Certify that

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of

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has successfully mastered the competencies required to perform the job of

ELECTRICAL INSTRUMENT REPAIRER

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The student named on this certificate has demonstrated mastery of the following unit level competencies required to perform the job of Electrical Instrument Repairer.

ELECTRICAL INSTRUMENT REPAIRER
(D.O.T. Code 729.281-026)

Safety Procedures and Tools
Identifying plant safety procedures
Observing safety precautions for tools and equipment
Identifying machinery safeguards
Observing safety in handling materials
Identifying work area safety precautions
Identifying fire prevention procedures
Handling hazardous materials
Observing electrical safety precautions
Identifying personal protection gear
Identifying and using hand tools
Identifying and using power tools
Identifying types of fasteners
Identifying and using wrenches and screwdrivers
Identifying and using pipefitting tools
Identifying and using plumbing tools
Identifying and using electrical tools
Identifying and using sheet metal tools
Identifying and using metalworking tools
Identifying and using hoisting and pulling tools

Blueprints, Schematics and Diagrams
Identifying basic principles of blueprint reading
Identifying elements of machine drawings
Reading electrical drawings
Using shop math to interpret blueprints
Identifying types of schematics used in plant engineering
Identifying guidelines for reading schematics
Reading electrical diagrams
Drawing electrical one-line diagrams from engineering sketches
Drawing electrical elementary diagrams from engineering sketches

Properties of Materials
Identifying the physical structure of metals
Identifying properties of metals
Identifying non-metal materials
Identifying properties and applications of carbon
Identifying properties of rubber
Identifying properties of industrial chemicals
Identifying the properties of paints, coatings and their applications
Identifying the properties of insulating materials and their applications
Identifying properties and applications of construction materials
Identifying properties and applications of wood
Identifying adhesives and tapes
Identifying basic principles of lubrication
Identifying oils and their applications
Identifying general purpose greases
Identifying lubricating compounds
Identifying hydraulic fluids

Identification of Test Instruments
Identifying and using basic measuring instruments
Identifying and using volt-ohm milliammeters (VOM)
Identifying and using electrical voltmeters (EVM)
Identifying and using ohmmeters
Using test instruments to measure voltage, current and resistance
Calculating values in DC network circuits

Physical Properties Measurements
Identifying the nature of force
Identifying physical properties of motion
Identifying principles of work and energy
Identifying principles of simple machines
Calculating area and volume
Identifying properties of friction

DC Measurement Principles
Understanding fundamentals of electrical theory and electrical measurement
Making calculations using Ohm's law
Measuring current in DC circuits
Measuring voltage in DC circuits
Calculating and measuring resistance in DC circuits
Calculating voltage, current and resistance in DC series circuits
Calculating total voltage, total current and total resistance in DC parallel circuits
Calculating and measuring electrical quantities in combination DC circuits
Calculating power in DC circuits
Applying fundamentals of magnetism and electromagnetism

Low Frequency Measurements
Calculating values for a right triangle
Identifying the characteristics of AC sine waves
Computing turns, voltage, current and impedance ratios of transformers
Determining reactance and impedance of a capacitor in either series or parallel circuits
Drawing phasor diagrams and calculating operating values for series AC circuits
Drawing phasor diagrams and calculating operating values for parallel AC circuits

Electrical Equipment Servicing
Performing a visual inspection of electronic equipment
Cleaning electronic equipment
Lubricating electronic equipment
Inspecting and replacing power cords and distribution cables
Inspecting and replacing vacuum tubes
Inspecting and replacing transistors
Inspecting and replacing IC units
Inspecting and replacing printed circuit boards
Performing a proof of performance on electronic equipment
Keeping records on maintenance of equipment

DC Techniques
Determining meter movement, sensitivity and resistance
Extending the current range of a meter movement
Extending the voltage range of a meter movement
Performing a condition test of a semi-conductor diode using an ohmmeter

Low Frequency Techniques
Testing an amplifier for amplification
Testing and repairing the vacuum tube amplifier
Testing and repairing a transistor amplifier
Identifying component parts and electrical characteristics of power supply circuits
Testing and repairing power supplies

CERTIFICATE OF COMPETENCY

This is to Certify that

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of

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has successfully mastered the competencies required to perform the job of

TEST TECHNICIAN

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The student named on this certificate has demonstrated mastery of the following unit level competencies required to perform the job of Test Technician.

TEST TECHNICIAN
(D.O.T. Code 019.161-014)

Safety Procedures and Tools
Identifying plant safety procedures
Observing safety precautions for tools and equipment
Identifying machinery safeguards
Observing safety in handling materials
Identifying work area safety precautions
Identifying fire prevention procedures

Blueprints, Schematics and Diagrams
Identifying basic principles of blueprint reading
Identifying elements of machine drawings
Identifying the symbols on electrical piping and fluid power diagrams
Identifying guidelines for reading schematics
Identifying electrical symbols
Reading electrical diagrams
Identifying piping symbols
Reading piping schematics
Identifying fluid power symbols
Reading fluid power schematics
Identifying welding symbols
Drawing electrical one-line diagrams from engineering sketches
Drawing electrical elementary diagrams from engineering sketches
Drawing electronic schematic diagrams from engineering sketches
Preparing preliminary sketches
Drawing logic symbols

Properties of Materials
Identifying the physical structure of metals
Identifying properties of metals
Identifying non-metal materials
Identifying properties and applications of carbon
Identifying properties of rubber
Identifying properties of industrial chemicals
Identifying the properties of paints, coatings and their applications
Identifying the properties of insulating materials and their applications
Identifying properties and applications of construction materials
Identifying properties and applications of wood
Identifying adhesives and tapes
Identifying basic principles of lubrication
Identifying oils and their applications
Identifying general purpose greases
Identifying lubricating compounds
Identifying hydraulic fluids
Identifying the processes used to produce steel
Identifying processes used to produce aluminum
Identifying processes for the production of magnesium and titanium
Identifying processes used to produce copper
Identifying processes used to produce lead, nickel, tin and zinc
Identifying common couplings
Identifying clutches

Identification of Test Instruments
Identifying and using basic measuring instruments
Identifying and using volt-ohm milliammeters (VOM)
Identifying and using electrical voltmeters (EVM)
Identifying and using ohmmeters
Identifying and using oscilloscopes
Identifying and using tube testers
Identifying and using transistor analyzers
Identifying and using capacitor testers
Identifying and using sine wave generators
Identifying and using signal generators
Identifying and using pulse generators
Identifying and using square wave generators
Identifying and using impedance testers
Identifying and using frequency meters
Using test instruments to measure voltage, current and resistance
Calculating values in DC network circuits
Calculating and measuring electrical values in AC capacitance circuits
Measuring inductance in series RL circuits
Calculating capacitance and time constants for RC circuits
Measuring AC values for LF circuits

Physical Properties Measurements
Identifying the nature of force
Identifying physical properties of motion
Identifying principles of work and energy
Identifying principles of simple machines
Calculating area and volume
Identifying properties of friction

DC Measurement Principles
Understanding fundamentals of electrical theory and electrical measurement
Making calculations using Ohm's law
Measuring current in DC circuits
Measuring voltage in DC circuits
Calculating and measuring resistance in DC circuits
Calculating voltage, current and resistance in DC series circuits
Inspecting and replacing vacuum tubes
Inspecting and replacing transistors
Inspecting and replacing IC units
Inspecting and replacing printed circuit (PC) boards
Performing a proof of performance on electronic equipment
Keeping records on maintenance of equipment

DC Techniques
Determining meter movement, sensitivity and resistance
Extending the current range of a meter movement
Extending the voltage range of a meter movement
Performing a condition test of a semi-conductor diode using an ohmmeter

Low Frequency Techniques
Testing an amplifier for amplification
Testing and repairing the vacuum tube amplifier
Testing and repairing a transistor amplifier
Identifying component parts and electrical characteristics of power supply circuits
Testing and repairing power supplies

High Frequency Techniques
Testing and repairing oscillators
Testing and repairing clampers
Testing and repairing clipper circuits
Testing and repairing counters
Constructing oscillators and performing a condition test of the oscillators
Constructing and performing condition tests of pulse circuits
Testing and repairing non-sinusoidal amplifiers
Troubleshooting sweep-generator circuits
Troubleshooting electronic circuits
Performing a condition test of zener diodes used in regulator circuits

Servicing Instrumentation Systems
Identifying automatic control system functions
Identifying the elements of process control
Identifying system transmitters and receivers process loops
Identifying diagram symbols and networks
Identifying parameters of an operational process control system
Identifying measurement purpose and requirements
Identifying the elements of measurement systems
Identifying instrument calibration standards units

Manufacturing Processes

Identifying practical applications of power
Identifying pneumatic principles
Identifying reciprocating compressors
Identifying rotary compressors
Identifying primary air treatment in pneumatic systems
Identifying secondary air treatment methods
Identifying piping, hoses and fittings used in pneumatic systems
Identifying control valves
Identifying pressure relief valves
Identifying cylinders
Identifying motors
Identifying components of pneumatic systems
Reading pneumatic schematic diagrams
Installing system components
Identifying procedures for pneumatic system maintenance
Determining system failures
Troubleshooting air compressors
Troubleshooting control valves
Troubleshooting cylinders
Troubleshooting air motors
Troubleshooting a pneumatic and hydraulic system
Identifying metal manufacturing processes
Identifying strainers and filters in hydraulic systems
Identifying reservoirs and accumulators in a a hydraulic system
Identifying hydraulic pumps on a system
Identifying piping, tubing and fittings
Identifying directional control valves
Identifying pressure control valves
Identifying cylinders in a hydraulic system
Identifying hydraulic motors
Troubleshooting hydraulic systems schematics
Reading hydraulic schematic diagrams
Installing hydraulic components
Installing pipes and tubes
Selecting hydraulic fluids
Planning system maintenance
Troubleshooting hydraulic systems (diagnostic technique)
Troubleshooting valves
Troubleshooting cylinders
Troubleshooting pumps and motors
Identifying basic packaging methods
Identifying actuating mechanisms
Identifying basic troubleshooting principles of packaging machinery
Identifying mechanical drives
Identifying motors and brakes
Identifying electrical controls
Identifying packaging materials
Identifying methods of filling containers
Identifying methods of sealing
Identifying the processes used for heat treatment of material
Identifying the processes used to produce plastics
Identifying the processes used to produce iron
Calculating total voltage, total current and total resistance in DC parallel circuits
Calculating and measuring electrical quantities in combination DC circuits
Calculating power in DC circuits
Applying fundamentals of magnetism and electromagnetism

Low Frequency Measurements

Calculating values for a right triangle
Identifying the characteristics of AC sine waves
Computing turns, voltage, current and impedance ratios of transformers
Determining reactance and impedance of a capacitor in either series or parallel circuits
Drawing phasor diagrams and calculating operating values for series AC circuits
Drawing phasor diagrams and calculating operating values for parallel AC circuits

High Frequency Measurement Principles

Understanding fundamentals of tuned AC circuits
Understanding fundamentals of semi-conductor materials
Identifying symbols and electrical characteristics of tunnel, varactor and high frequency diodes
Understanding the fundamentals of bipolar transistors and their electrical characteristics
Performing condition tests of bipolar transistors
Understanding the fundamentals of field effect transistors and their electrical characteristics
Understanding the fundamentals of thyristors and their electrical characteristics
Understanding fundamentals of integrated circuits
Defining the operating values and applications of opto-electronic devices
Identifying the component parts and operational characteristics of diode vacuum tubes
Identifying the component parts and operating characteristics of triode vacuum tubes
Identifying the component parts and operating characteristics of tetrode vacuum tubes
Identifying the component parts and operating characteristics of pentode vacuum tubes
Performing condition testing of the thermal stability and operational parameters of a common-emitter amplifier circuit
Performing condition testing of DC and audio amplifiers
Defining electrical characteristics, applications and normal operational values of amplifiers

Electrical Equipment Servicing

Performing a visual inspection of electronic equipment
Cleaning electronic equipment
Lubricating electronic equipment
Inspecting and replacing power cords and distribution cables
Analyzing systems using troubleshooting flow sheet
Identifying pressure principles
Identifying pressure sensors
Identifying pressure transducers
Identifying low pressure measurement gage requirements
Installing and servicing pressure instruments
Identifying force, stress and strain measurement units
Identifying weight and mass measuring instruments
Identifying methods for weighing materials in motion
Identifying displacement measurement methods
Identifying acceleration, vibration and shock measurement methods
Identifying the properties of fluid flow measurement
Identifying primary measuring devices for fluid flow
Identifying secondary measuring devices for fluid flow
Identifying applications for variable area instruments
Identifying open channel flow devices
Identifying applications for positive displacement meters
Identifying applications for turbine and magnetic flow meters
Identifying types of fluid flow meters
Identifying solid particles flow metering methods
Installing and maintaining flow instruments
Identifying level measurement instruments
Identifying pressure head instruments
Identifying electrical methods for level measurement
Identifying solid level measuring systems
Servicing level measuring instruments
Identifying temperature measurement principles
Identifying bimetallic and fluid filled temperature measuring instruments
Identifying instruments using electrical methods of measuring temperature
Identifying pyrometers
Performing temperature measuring instrument maintenance and calibration
Identifying final control elements in process loops
Identifying electric activators
Identifying pneumatic and hydraulic activators
Identifying control valves
Identifying control element applications
Identifying on-site safety standards and maintenance practices
Identifying servicing requirements
Detailing electrical and electronic stations
Detailing pneumatic and hydraulic stations
Detailing troubleshooting requirements

Designing and Modifying Systems

Designing voltage amplifiers

Designing and Modifying Systems (Continued)
Designing wave shape circuits
Designing logic circuits
Modifying schematics
Laying out, taping up and drawing basic printed circuit boards
Constructing printed circuit (PC) boards
Modifying circuits to accommodate integrated circuits (IC)
Preparing assembly guides
Preparing parts lists
Making truth tables for logic gates

CERTIFICATE OF COMPETENCY

This is to Certify that

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of

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has successfully mastered the competencies required to perform the job of

INSTRUMENT MECHANIC

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V-45

The student named on this certificate has demonstrated mastery of the following unit level competencies required to perform the job of Instrument Mechanic.

INSTRUMENT MECHANIC
(D.O.T. Code 710.381-042)

Safety Procedures and Tools

Identifying plant safety procedures
Observing safety precautions for tools and equipment
Identifying machinery safeguards
Observing safety in handling materials
Identifying work area safety precautions
Identifying fire prevention procedures
Handling hazardous materials
Observing electrical safety precautions
Identifying personal protection gear
Identifying and using hand tools
Identifying and using power tools
Identifying types of fasteners
Identifying and using wrenches and screwdrivers
Identifying and using pipefitting tools
Identifying and using plumbing tools
Identifying and using electrical tools
Identifying and using sheet metal tools
Identifying and using metalworking tools
Identifying and using hoisting and pulling tools

Identification of Test Instruments

Identifying and using basic measuring instruments
Identifying and using volt-ohm milliammeters (VOM)
Identifying and using ohmmeters

Physical Properties Measurements

Identifying the nature of force
Identifying physical properties of motion
Identifying principles of work and energy
Identifying principles of simple machines
Calculating area and volume
Identifying properties of friction

DC Measurement Principles

Understanding fundamentals of electrical theory and electrical measurement
Making calculations using Ohm's law
Measuring current in DC circuits
Measuring voltage in DC circuits
Calculating and measuring resistance in DC circuits
Calculating voltage, current and resistance in series circuits
Calculating total voltage, total current and total resistance in DC parallel circuits
Calculating and measuring electrical quantities in combination DC circuits
Calculating power in DC circuits
Applying fundamentals of magnetism and electromagnetism

V-47

CERTIFICATE OF COMPETENCY

This is to Certify that

of

has successfully mastered the competencies required to perform the job of

INSPECTOR

The student named on this certificate has demonstrated mastery of the following unit level competencies required to perform the job of Inspector.

INSPECTOR
(D.O.T. Code 710.384-014)

Safety Procedures and Tools
Identifying plant safety procedures
Observing safety precautions for tools and equipment
Identifying machinery safeguards
Observing safety in handling materials
Identifying work area safety precautions
Identifying fire prevention procedures
Handling hazardous materials
Observing electrical safety precautions
Identifying personal protection gear
Identifying and using hand tools
Identifying and using power tools
Identifying types of fasteners
Identifying and using wrenches and screwdrivers
Identifying and using pipefitting tools
Identifying and using plumbing tools
Identifying and using electrical tools
Identifying and using sheet metal tools
Identifying and using metalworking tools
Identifying and using hoisting and pulling tools

Blueprints, Schematics and Diagrams
Identifying basic principles of blueprint reading
Identifying elements of machine drawings
Using shop math to interpret blueprints
Identifying types of schematics used in plant engineering
Identifying guidelines for reading schematics

Properties of Materials
Identifying the physical structure of metals
Identifying properties of metals
Identifying non-metal materials
Identifying properties and applications of carbon
Identifying properties of rubber
Identifying properties of industrial chemicals
Identifying the properties of paints, coatings and their applications
Identifying the properties of insulating materials and their applications
Identifying properties and applications of construction materials
Identifying properties and applications of wood
Identifying adhesives and tapes
Identifying basic principles of lubrication
Identifying oils and their applications
Identifying general purpose greases
Identifying lubricating compounds
Identifying hydraulic fluids

Identification of Test Instruments
Identifying and using basic measuring instruments
Identifying and using volt-ohm milliammeters (VOM)
Identifying and using ohmmeters

Physical Properties Measurements
Identifying the nature of force
Identifying physical properties of motion
Identifying principles of work and energy
Identifying principles of simple machines
Calculating area and volume
Identifying properties of friction

V-49

CERTIFICATE OF COMPETENCY

This is to Certify that

of

has successfully mastered the competencies required to perform the job of

ASSEMBLER

The student named on this certificate has demonstrated mastery of the following unit level competencies required to perform the job of Assembler.

ASSEMBLER

(D.O.T. Code 710.681-010)

Safety Procedures and Tools

Identifying plant safety procedures
Observing safety precautions for tools and equipment
Identifying machinery safeguards
Observing safety in handling materials
Identifying work area safety precautions
Identifying fire prevention procedures
Handling hazardous materials
Observing electrical safety precautions
Identifying personal protection gear
Identifying and using hand tools
Identifying and using power tools
Identifying types of fasteners
Identifying and using wrenches and screwdrivers
Identifying and using pipefitting tools
Identifying and using plumbing tools
Identifying and using electrical tools
Identifying and using sheet metal tools
Identifying and using metalworking tools
Identifying and using hoisting and pulling tools

Blueprints, Schematics and Diagrams

Identifying basic principles of blueprint reading
Identifying elements of machine drawings
Reading electrical drawings
Using shop math to interpret blueprints
Identifying guidelines for reading schematics
Reading electrical diagrams

Identification of Test Instruments

Identifying and using basic measuring instruments
Identifying and using volt-ohm milliammeters (VOM)
Identifying and using electrical voltmeters (EVM)
Identifying and using ohmmeters
Using test instruments to measure voltage, current and resistance

Physical Properties Measurements

Identifying the nature of force
Identifying physical properties of motion
Identifying principles of work and energy
Identifying principles of simple machines
Calculating area and volume
Identifying properties of friction

DC Measurement Principles

Understanding fundamentals of electrical theory and electrical measurement
Making calculations using Ohm's law
Measuring current in DC circuits
Measuring voltage in DC circuits
Calculating and measuring resistance in DC circuits
Calculating voltage, current and resistance in DC series circuits
Calculating total voltage, total current and total resistance in DC parallel circuits
Calculating and measuring electrical quantities in combination DC circuits
Calculating power in DC circuits
Applying fundamentals of magnetism and electromagnetism

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CERTIFICATE OF COMPETENCY

This is to Certify that

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of

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has successfully mastered the competencies required to perform the job of

CALIBRATOR

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The student named on this certificate has demonstrated mastery of the following unit level competencies required to perform the job of Calibrator.

CALIBRATOR
(D.O.T. Code 710.681-014)

Safety Procedures and Tools
Identifying plant safety procedures
Observing safety precautions for tools and equipment
Identifying machinery safeguards
Observing safety in handling materials
Identifying work area safety precautions
Identifying fire prevention procedures
Handling hazardous materials
Observing electrical safety precautions
Identifying personal protection gear
Identifying and using hand tools
Identifying and using power tools
Identifying types of fasteners
Identifying and using wrenches and screwdrivers
Identifying and using pipefitting tools
Identifying and using plumbing tools
Identifying and using electrical tools
Identifying and using sheet metal tools
Identifying and using metalworking tools
Identifying and using hoisting and pulling tools

Blueprints, Schematics and Diagrams
Identifying basic principles of blueprint reading
Identifying elements of machine drawings
Reading electrical drawings
Using shop math to interpret blueprints
Identifying types of schematics used in plant engineering
Identifying guidelines for reading schematics
Identifying electrical symbols
Reading electrical diagrams

Properties of Materials
Identifying the physical structure of metals
Identifying properties of metals
Identifying non-metal materials
Identifying properties and applications of carbon
Identifying properties of rubber
Identifying properties of industrial chemicals
Identifying the properties of paints, coatings and their applications
Identifying the properties of insulating materials and their applications
Identifying properties and applications of construction materials
Identifying properties and applications of wood
Identifying adhesives and tapes
Identifying basic principles of lubrication
Identifying oils and their applications
Identifying general purpose greases
Identifying lubricating compounds
Identifying hydraulic fluids

Identification of Test Instruments
Identifying and using basic measuring instruments
Identifying and using volt-ohm milliammeters (VOM)
Identifying and using ohmmeters
Identifying and using sine wave generators

Physical Properties Measurements
Identifying the nature of force
Identifying physical properties of motion
Identifying principles of work and energy
Identifying principles of simple machines
Calculating area and volume
Identifying properties of friction

Low Frequency Measurements
Calculating values for a right triangle
Identifying the characteristics of AC sine waves

DC Techniques
Determining meter movement, sensitivity and resistance
Extending the current range of a meter movement
Extending the voltage range of a meter movement
Performing a condition test of a semi-conductor diode using an ohmmeter

Low Frequency Techniques
Testing an amplifier for amplification
Testing and repairing the vacuum tube amplifier

CERTIFICATE OF COMPETENCY

This is to Certify that

of

has successfully mastered the competencies required to perform the job of

INSTRUMENT TECHNICIAN HELPER

The student named on this certificate has demonstrated mastery of the following unit level competencies required to perform the job of Instrument Technician Helper.

INSTRUMENT TECHNICIAN HELPER
(D.O.T. Code 710.684-030)

Safety Procedures and Tools

Identifying plant safety procedures
Observing safety precautions for tools and equipment
Identifying machinery safeguards
Observing safety in handling materials
Identifying work area safety precautions
Identifying fire prevention procedures
Handling hazardous materials
Observing electrical safety precautions
Identifying personal protection gear
Identifying and using hand tools
Identifying and using power tools
Identifying types of fasteners
Identifying and using wrenches and screwdrivers
Identifying and using pipefitting tools
Identifying and using plumbing tools
Identifying and using electrical tools
Identifying and using sheet metal tools
Identifying and using metalworking tools
Identifying and using hoisting and pulling tools

Identification of Test Instruments

Identifying and using basic measuring instruments
Identifying and using volt-ohm milliammeters (VOM)
Identifying and using ohmmeters

Servicing Instrumentation Systems

Identifying automatic control system functions
Identifying the elements of process control
Identifying system transmitters and receivers process loops
Identifying diagram symbols and networks
Identifying parameters of an operational process control system
Identifying measurement purpose and requirements
Identifying the elements of measurement systems
Identifying measurement transducers
Identifying instrument calibration standards units
Analyzing systems using troubleshooting flow sheet

CERTIFICATE OF COMPETENCY

This is to Certify that

of

has successfully mastered the competencies required to perform the job of

CALIBRATION LABORATORY TECHNICIAN

The student named on this certificate has demonstrated mastery of the following unit level competencies required to perform the job of Calibration Laboratory Technician.

CALIBRATION LABORATORY TECHNICIAN
(D.O.T. Code 019.281-010)

Safety Procedures and Tools

Identifying plant safety procedures
Observing safety precautions for tools and equipment
Identifying machinery safeguards
Observing safety in handling materials
Identifying work area safety precautions
Identifying fire prevention procedures
Handling hazardous materials
Observing electrical safety precautions
Identifying personal protection gear
Identifying and using hand tools
Identifying and using power tools
Identifying types of fasteners
Identifying and using wrenches and screwdrivers
Identifying and using pipefitting tools
Identifying and using plumbing tools
Identifying and using electrical tools
Identifying and using sheet metal tools
Identifying and using metalworking tools
Identifying and using hoisting and pulling tools

Blueprints, Schematics and Diagrams

Identifying basic principles of blueprint reading
Identifying elements of machine drawings
Identifying the symbols on electrical piping and fluid power diagrams
Identifying guidelines for reading schematics
Identifying electrical symbols
Reading electrical diagrams
Identifying piping symbols
Reading piping schematics
Identifying fluid power symbols
Reading fluid power schematics
Identifying welding symbols
Drawing electrical one-line diagrams from engineering sketches
Drawing electrical elementary diagrams from engineering sketches
Drawing electronic schematic diagrams from engineering sketches
Preparing preliminary sketches
Drawing logic symbols
Identifying and using square wave generators
Identifying and using impedance testers
Identifying and using frequency meters
Using test instruments to measure voltage, current and resistance
Calculating values in DC network circuits
Calculating and measuring electrical values in AC capacitance circuits
Measuring inductance in series RL circuits
Calculating capacitance and time constants for RC circuits
Measuring AC values for LF circuits

Physical Properties Measurements

Identifying the nature of force
Identifying physical properties of motion
Identifying principles of work and energy
Identifying principles of simple machines
Calculating area and volume
Identifying properties of friction

DC Measurement Principles

Understanding fundamentals of electrical theory and electrical measurement
Making calculations using Ohm's law
Measuring current in DC circuits
Measuring voltage in DC circuits
Calculating and measuring resistance in DC circuits
Calculating voltage, current and resistance in DC series circuits
Calculating total voltage, total current and total resistance in DC parallel circuits
Calculating and measuring electrical quantities in combination DC circuits
Calculating power in DC circuits
Applying fundamentals of magnetism and electromagnetism

Low Frequency Measurements

Calculating values for a right triangle
Identifying the characteristics of AC sine waves
Computing turns, voltage, current and impedance ratios of transformers
Performing condition testing of DC and audio amplifiers
Defining electrical characteristics, applications and normal operational values of amplifiers

Electrical Equipment Servicing

Performing a visual inspection of electronic equipment
Cleaning electronic equipment
Lubricating electronic equipment
Inspecting and replacing power cords and distribution cables
Inspecting and replacing vacuum tubes
Inspecting and replacing transistors
Inspecting and replacing IC units
Inspecting and replacing printed circuit (PC) boards
Performing a proof of performance on electronic equipment
Keeping records on maintenance of equipment

DC Techniques

Determining meter movement, sensitivity and resistance
Extending the current range of a meter movement
Extending the voltage range of a meter movement
Performing a condition test of a semi-conductor diode using an ohmmeter

Low Frequency Techniques

Testing an amplifier for amplification
Testing and repairing the vacuum tube amplifier
Testing and repairing a transistor amplifier
Identifying component parts and electrical characteristics of power supply circuits
Testing and repairing power supplies

High Frequency Techniques

Testing and repairing oscillators
Testing and repairing clampers
Testing and repairing clipper circuits
Testing and repairing counters
Constructing oscillators and performing a condition test of the oscillators

Properties of Materials

Identifying the physical structure of metals
Identifying properties of metals
Identifying non-metal materials
Identifying properties and applications of carbon
Identifying properties of rubber
Identifying properties of industrial chemicals
Identifying the properties of paints, coatings and their applications
Identifying the properties of insulating materials and their applications
Identifying properties and applications of construction materials
Identifying properties and applications of wood
Identifying adhesives and tapes
Identifying basic principles of lubrication
Identifying oils and their applications
Identifying general purpose greases
Identifying lubricating compounds
Identifying hydraulic fluids

Identification of Test Instruments

Identifying and using basic measuring instruments
Identifying and using volt-ohm milliammeters (VOM)
Identifying and using electrical voltmeters (EVM)
Identifying and using ohmmeters
Identifying and using oscilloscopes
Identifying and using tube testers
Identifying and using transistor analyzers
Identifying and using capacitor testers
Identifying and using sine wave generators
Identifying and using signal generators
Identifying and using pulse generators

Determining reactance and impedance of a capacitor in either series or parallel circuits
Drawing phasor diagrams and calculating operating values for series AC circuits
Drawing phasor diagrams and calculating operating values for parallel AC circuits

High Frequency Measurement Principles

Understanding fundamentals of tuned AC circuits
Understanding fundamentals of semi-conductor materials
Identifying symbols and electrical characteristics of tunnel, varactor and high frequency diodes
Understanding the fundamentals of bipolar transistors and their electrical characteristics
Performing condition tests of bipolar transistors
Understanding the fundamentals of field effect transistors and their electrical characteristics
Understanding the fundamentals of thyristors and their electrical characteristics
Understanding fundamentals of integrated circuits
Defining the operating values and applications of opto-electronic devices
Identifying the component parts and operational characteristics of diode vacuum tubes
Identifying the component parts and operating characteristics of triode vacuum tubes
Identifying the component parts and operating characteristics of tetrode vacuum tubes
Identifying the component parts and operating characteristics of pentode vacuum tubes
Performing condition testing of the thermal stability and operational parameters of a common-emitter amplifier circuit

Constructing and performing condition tests of pulse circuits
Testing and repairing non-sinusoidal amplifiers
Troubleshooting sweep-generator circuits
Performing a condition test of zener diodes used in regulator circuits

Calibration of Test Instruments

Performing condition test and calibration of volt-ohm milliameter (VOM)
Performing condition test and calibration of electrical voltmeters (EVM)
Performing condition test and calibration of tube testers
Performing condition test and calibration of a transistor tester
Performing condition test and calibration of resistor substitution box
Performing condition test and calibration of oscilloscopes
Performing condition test and calibration of sine wave generators
Performing condition test and calibration of square wave generators
Performing condition test and calibration of frequency meters
Calibrating power supply voltage

GROUP PROGRESS CHART

NAME	UNITS/TASKS																	

SECTION VI

FACILITIES

SECTION VI

Section VI Content List

Group Instruction Facilities
Individualized Instruction Facilities

The facility layouts on the following pages are presented to aid in arranging the classroom and laboratory for efficient instruction. The school administration and program instructor must determine an arrangement that best fits the needs of the students by determining the most efficient use of resources available to them not only in the laboratory, but also in the Learning Resource Center settings.

FACILITY LAYOUTS

The layouts on the following pages illustrate how facilities for group and individualized instructional programs may be planned and set up.

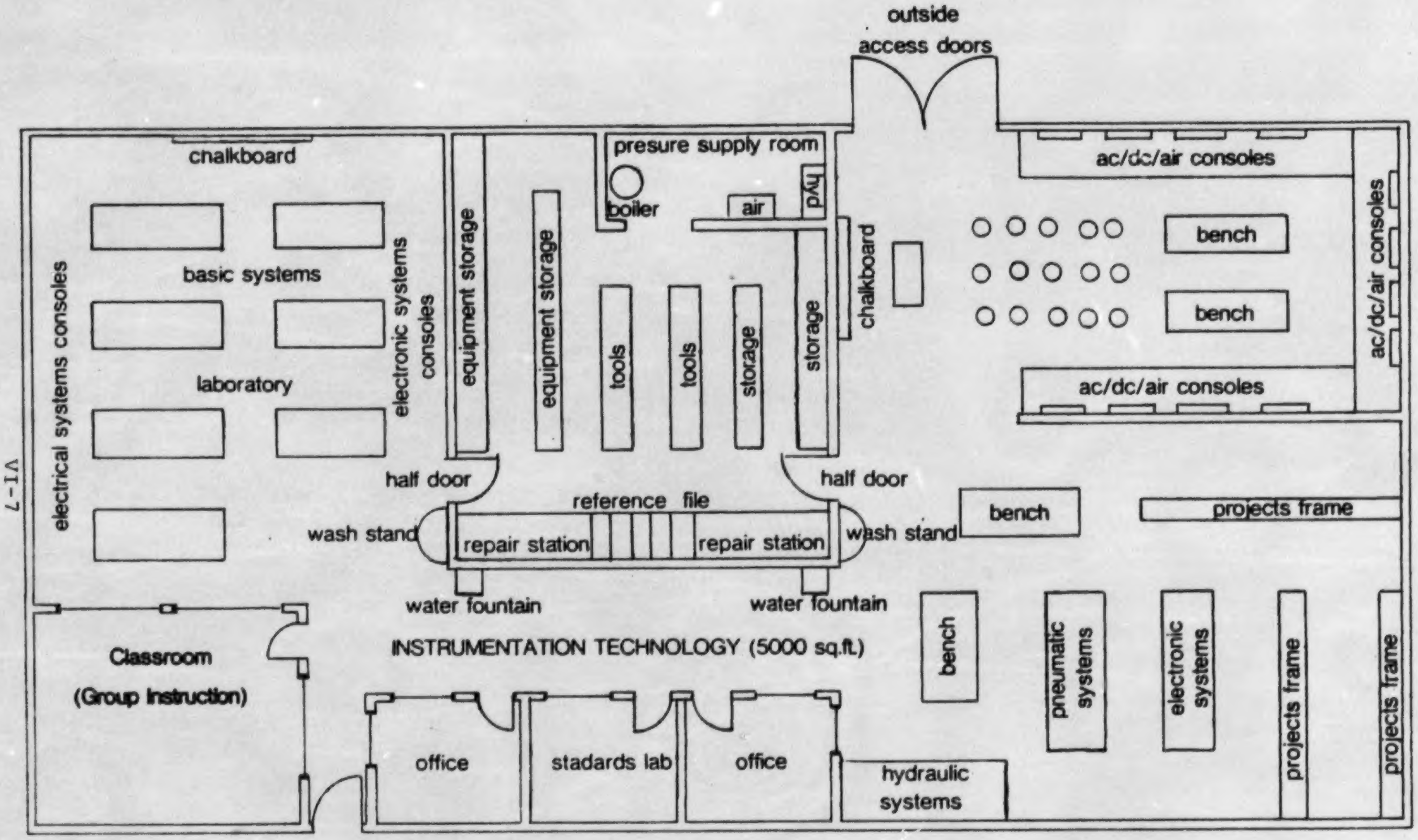
Each instructional approach has two important physical areas. These are (1) the laboratory (work) area and classroom for group instruction and (2) the laboratory (work) area and learning resource center (LRC) for individualized instruction.

The instructional setting for group instruction is based on that of a traditional classroom. This approach is easily set up and includes little or no modifications. The primary modes of learning are instructor lectures, occasional use of audiovisual aids and student participation. Ideally, all students progress at the same pace.

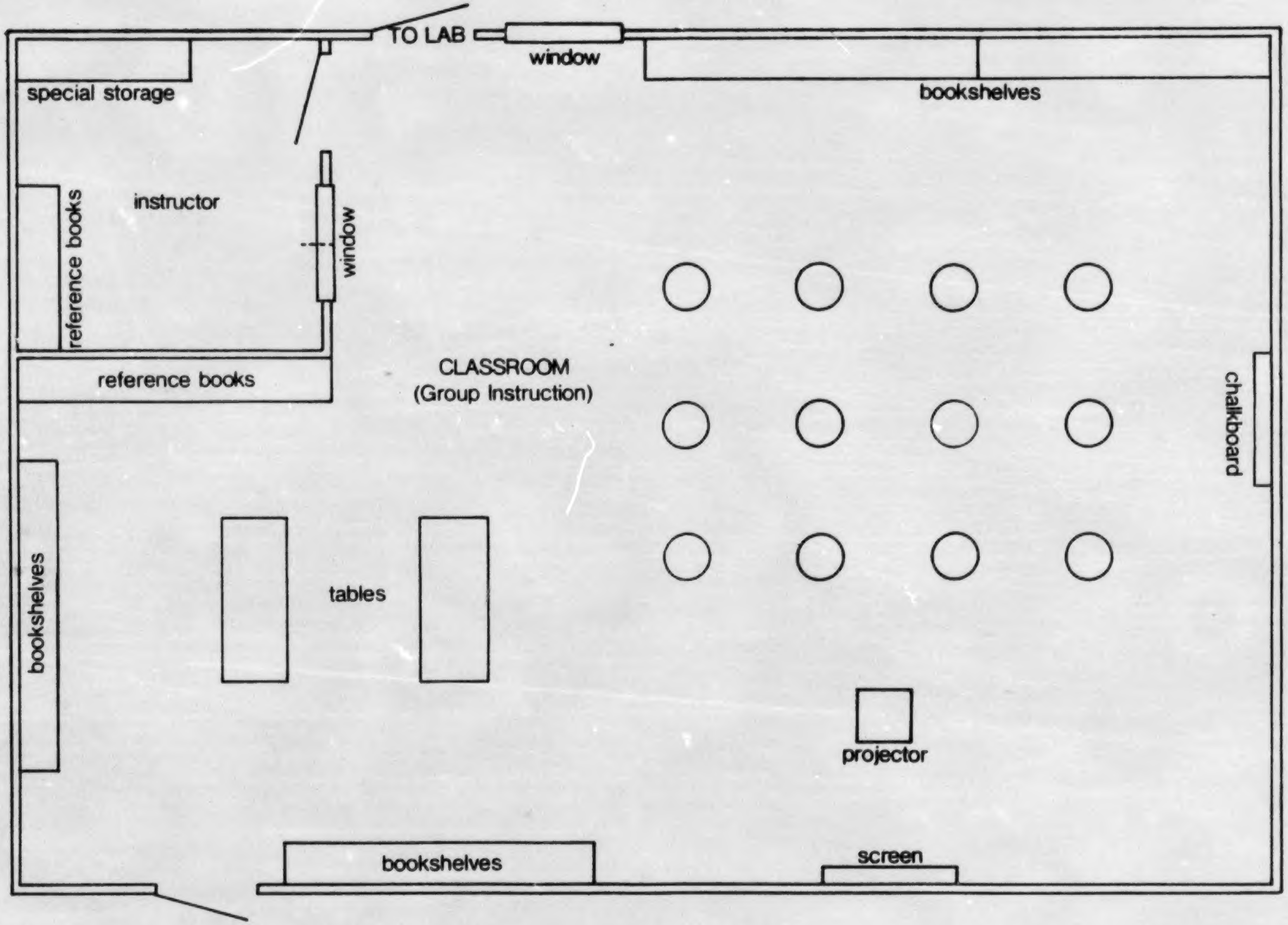
The instructional setting for individual instruction is designed to facilitate a student self-paced progression of learning. The LRC requires careful planning in utilizing available space. When planning to install an individual instruction program in an area not originally designed for this approach, the instructional setting may need modifications. Desks may be replaced with study carrels to allow students to simultaneously participate in a variety of learning activities. A group session area for small group gatherings should also be included. Because the instructor and students rarely meet together as a group, a bulletin board becomes a vital communication device in an LRC. It can be used to post announcements and such instructional information as group progress charts, assignments, positions available in the industry and safety rules.

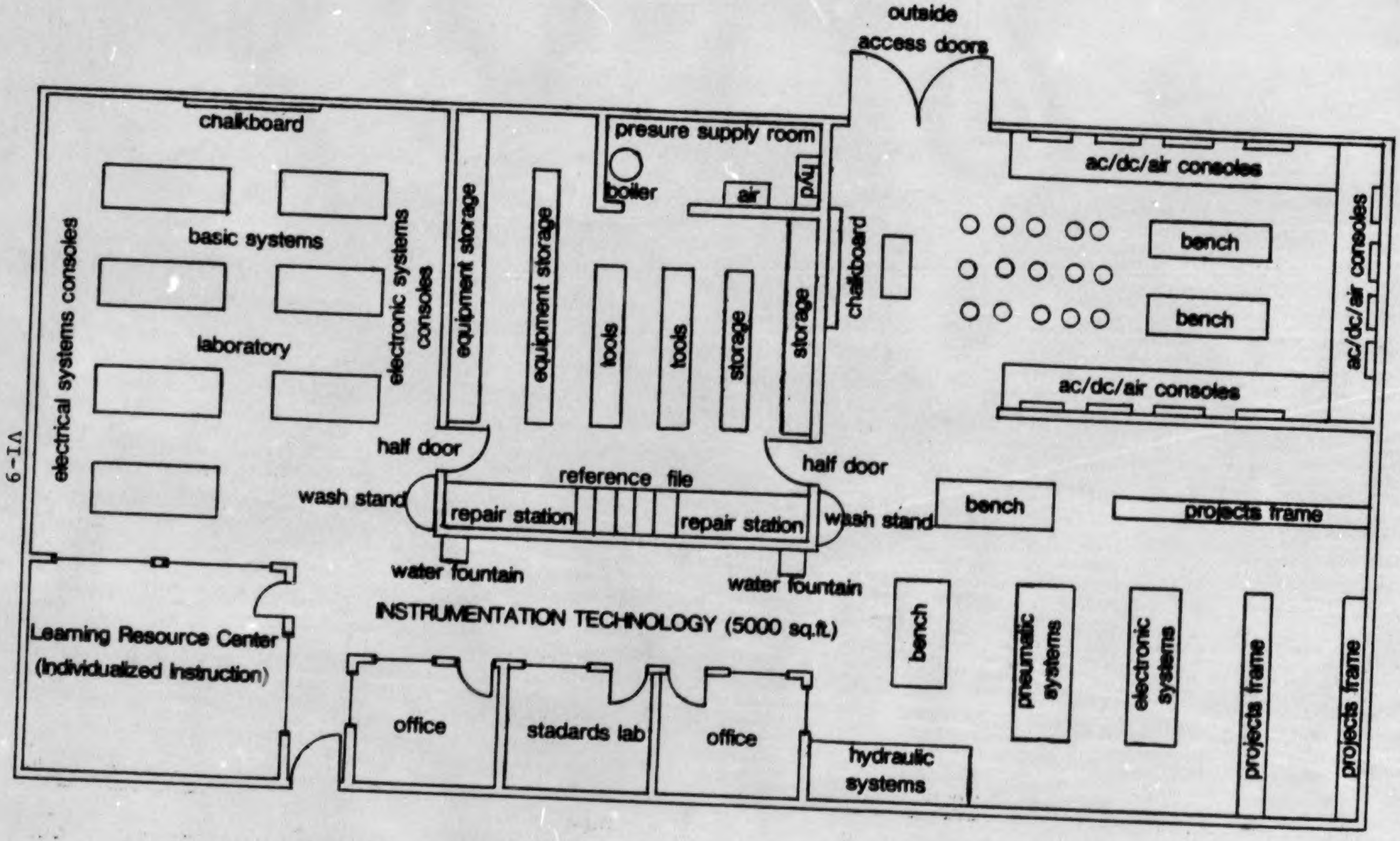
A variety of references, resources and media equipment should be made available to the student. Therefore, an adequate amount of storage area should be included in planning the LRC. Every specific school and department has unique physical layout characteristics and problems. Through innovation, these features may be transformed into LRC advantages rather than disadvantages.

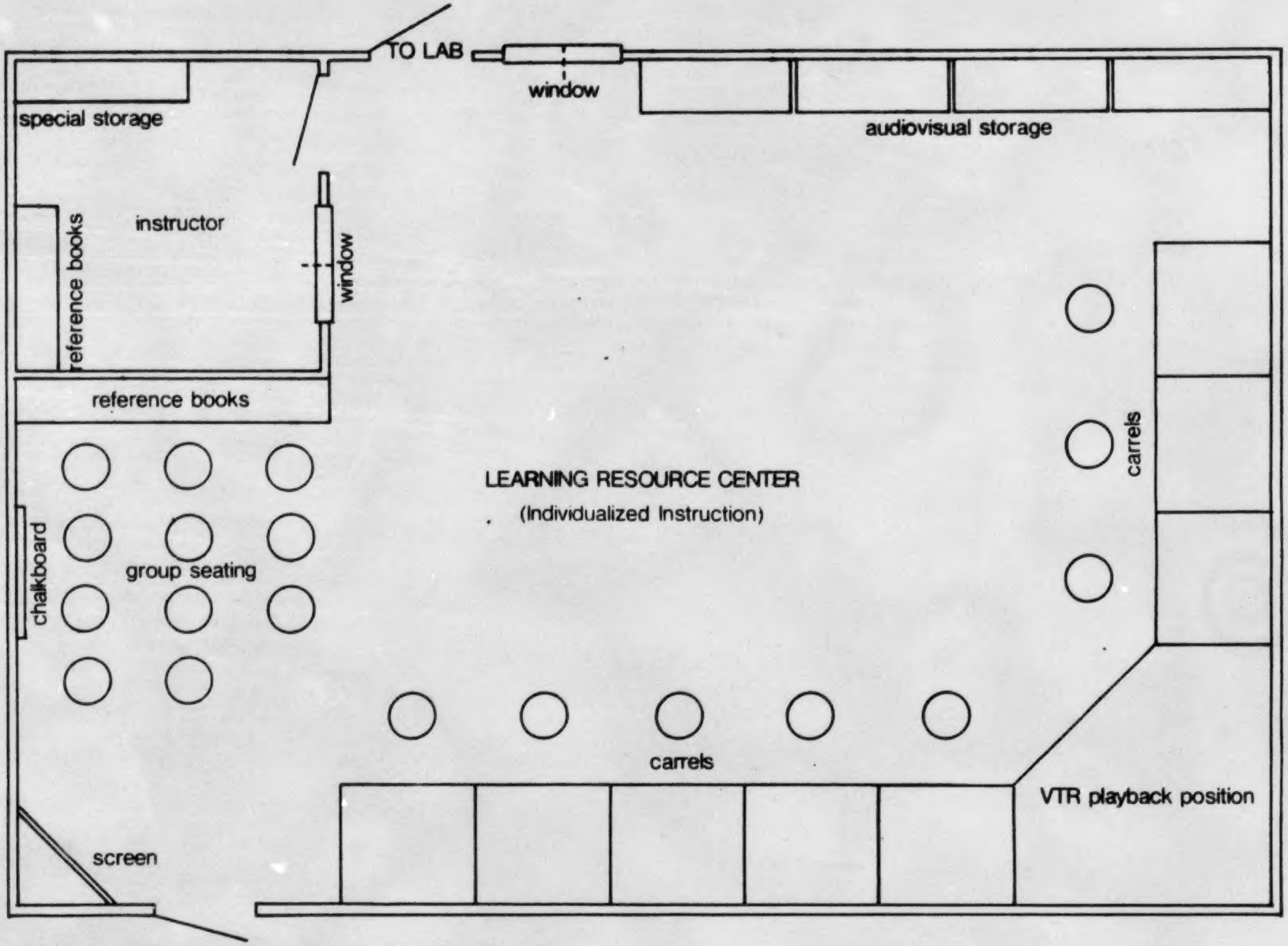
The manner in which the laboratory (work) area is planned and set up need not be affected by the type of instructional approach used by an instructor; it could/will be the same. Some major concerns in the laboratory are: 1) the instructor must always have a clear line of sight to each and every workstation, 2) tools must be accessible to students, but under the control of the instructor and 3) all supplies and materials required for the day's activities must be on hand and ready to use.


INSTRUMENTATION TECHNOLOGY (5000 sq.ft.)

outside
access doors
chalkboard
basic systems
laboratory
electrical systems consoles
electronic systems consoles
equipment storage
equipment storage
presure supply room
boiler
air
hyd
tools
tools
storage
storage
chalkboard
ac/dc/air consoles
bench
bench
ac/dc/air consoles
ac/dc/air consoles
half door
half door
reference file
wash stand
repair station
repair station
wash stand
bench
projects frame
water fountain
water fountain
Classroom
(Group Instruction)
office
stadards lab
office
hydraulic systems
bench
pneumatic systems
electronic systems
projects frame
projects frame


TO LAB
window
special storage
bookshelves
instructor
reference books
window
reference books
CLASSROOM
(Group Instruction)
chalkboard
bookshelves
tables
projector
bookshelves
screen


outside access doors
chalkboard
presure supply room
boiler
air
hyd
ac/dc/air consoles
basic systems
laboratory
electrical systems consoles
electronic systems consoles
equipment storage
equipment storage
tools
tools
storage
storage
chalkboard
bench
bench
ac/dc/air consoles
ac/dc/air consoles
half door
half door
reference file
wash stand
repair station
repair station
wash stand
bench
projects frame
water fountain
water fountain
INSTRUMENTATION TECHNOLOGY (5000 sq.ft.)
Learning Resource Center (Individualized Instruction)
office
stadards lab
office
hydraulic systems
bench
pneumatic systems
electronic systems
projects frame
projects frame


TO LAB
window
special storage
audiovisual storage
instructor
reference books
window
reference books
carrels
LEARNING RESOURCE CENTER
(Individualized Instruction)
chalkboard
group seating
carrels
VTR playback position
screen

801

802

Federal law prohibits discrimination on the basis of race, color or national origin (Title VI of the Civil Rights Act of 1964); sex (Title IX of the Educational Amendments of 1972 and Title II of the Vocational Education Amendments of 1976); or handicap (Section 504 of the Rehabilitation Act of 1973) in educational programs or activities receiving federal financial assistance.

Employees, students and the general public are hereby notified that the Georgia Department of Education does not discriminate in any educational programs or activities or in employment policies.

The following individuals have been designated as the employees responsible for coordinating the department's effort to implement this nondiscriminatory policy.

Title II - Loydia Webber, Vocational Equity Coordinator
Title VI - Peyton Williams Jr., Associate Superintendent
of State Schools and Special Services
Title IX - Evelyn Rowe and Myra Tolbert, Coordinators
Section 504 - Jane Lee, Coordinator of Special Education

Inquiries concerning the application of Title II, Title VI, Title IX or Section 504 to the policies and practices of the department may be addressed to the persons listed above at the Georgia Department of Education, State Office Building, Atlanta 30334; to the Regional Office for Civil Rights, Atlanta 30323; or to the Director, Office for Civil Rights, Education Department, Washington, D.C. 20201.